

# **Amphibian and Reptile Inventory and Monitoring Grand Teton and Yellowstone National Parks, 2000-2003 Final Report**



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*cover photos: Columbia Spotted Frog at String Lake, GRTE; Boreal Toad tadpoles at Gibbon Meadow, YELL; Intermountain Wandering Gartersnake at Snake River Hot Springs, YELL.*

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# **Amphibian and Reptile Inventory and Monitoring**

## **Grand Teton and Yellowstone National Parks, 2000-2003**

### **Final Report**

#### **Executive Summary**

Amphibian and reptile surveys have been conducted in Grand Teton (GRTE) and Yellowstone (YELL) national parks since 2000, supported by the United States Geological Survey's Amphibian Research & Monitoring Initiative and National Park Service's Inventory & Monitoring program. This is the final report for the inventory project, covering 2000 through 2003. For amphibians, work consisted of systematic surveys in randomly selected catchments, targeted species searches, and monitoring of a frog population at a long-term study area. For reptiles, searches were conducted in likely habitat for targeted species. Species lists were updated: 5 species of amphibians and 4 species of reptiles are present in GRTE; 4 species of amphibians and 6 species of reptiles are present in YELL. Several other species of amphibians and reptiles are historic and/or remain unconfirmed in the parks.

This project provided the first systematically-collected amphibian occurrence data for YELL and GRTE, including remote areas where amphibians have not been documented previously. Surveys of potential amphibian breeding habitat were conducted at 150+ sites in 13 catchments in GRTE, and at 466 sites in 19 catchments in YELL. The Columbia Spotted Frog was the most widely distributed species in both parks; the Boreal Toad was the least common. In YELL, more breeding sites were found for Boreal Chorus Frogs than any other species in all 4 years of surveys. In GRTE, Boreal Chorus Frogs vied with Columbia Spotted Frogs for having the most numerous breeding sites. Statistical methods are being developed and tested with these data to provide unbiased estimates of proportion of area occupied, which can be used to investigate amphibian population trends across the parks.

Targeted surveys for Northern Leopard Frogs failed to detect this species in areas that were historically occupied or where leopard frogs were recently reported: the species remains historic and unconfirmed in GRTE, and unconfirmed in YELL. Targeted surveys of previously-identified breeding sites for Boreal Toads indicated that the species persists at most of these sites, but concerns remain about disease and the potential for declines. Among reptiles, the Intermountain Wandering Gartersnake is the most common and widely-distributed species in both parks. Other reptile species (except the Rubber Boa, which is uncommon but widely distributed) appear to be mostly confined to certain areas within the parks, such as low elevations or thermal areas.

A Columbia Spotted Frog population near Lodge Creek was studied historically (1950s) and has been monitored annually since the early 1990s. Recruitment was low 2001-2003, probably due to drought. Nearly the entire cohort of young-of-the-year spotted frogs at the mouth of Lodge Creek were infected by encysted parasites in 2003, a phenomenon that has not been seen previously elsewhere in the parks or northwest Wyoming to our knowledge.

Diagnostic examinations by USGS of collected specimens (found dead) revealed that two major infectious diseases are present in amphibian populations of YELL: ranavirus and chytridiomycosis (chytrid fungal disease).

## **Introduction**

This is the final, cumulative report on herpetological inventory and monitoring in Yellowstone National Park (YELL) and Grand Teton National Park (GRTE), covering the period 2000 through 2003. GRTE includes the John D. Rockefeller Memorial Parkway (JODR). Annual progress reports were submitted for 2001 (Patla and Peterson 2002) and 2002 (Patla and Peterson 2003). Copies of this report will be provided to the Greater Yellowstone Network Inventory and Monitoring Program (GRYE I&M), YELL and GRTE resource management, and the USGS Amphibian Research and Monitoring Initiative.

Work was financially supported by the USGS Amphibian Research & Monitoring Initiative (USGS-ARMI) and the National Park Service Inventory & Monitoring Program (NPS-I&M). YELL and GRTE provided multiple forms of logistic support including research and camping permits, occasional boat transport across Jackson and Yellowstone lakes, bear safety training, campground fee waivers at GRTE, and inexpensive lodging for the field crew in YELL.

This report provides an updated list of herpetofauna species in GRTE and YELL. It contains three main sections covering the three project components: systematic surveys, targeted species surveys, and apex monitoring at a long-term study area. Each section includes background information, methods, results and discussion. There is also a section and appendix on amphibian diseases. Relational databases submitted on a CD with this report provide data documenting sampling events and findings. The CD also contains ArcView GIS themes depicting locations and habitat characteristics of species, digital photographs of sites surveyed, and digital voucher photos of species.

## **Updated Lists of Herpetofauna Species**

Appendix I provides lists of amphibian and reptile species occurring in GRTE and YELL. Species names have been verified and updated as needed based on Crother (2001). Species absence is extremely difficult to determine (Fellers 1997), and it is possible that some species recorded historically or occasionally but not detected during our survey efforts may still be present in the parks.

## **Systematic amphibian surveys**

### **Background**

The main focus of field work 2000-2003 was the survey of potential amphibian breeding habitat in randomly-selected watershed units across YELL and GRTE. This task is referred to as systematic surveys in our GRYE study plan, and as mid-level monitoring in our USGS-ARMI proposals. The approach was designed and implemented initially as a pilot study in 2000 under USGS-ARMI (Patla 2001). In 2001, 2002, and 2003, it was funded jointly by the NPS-I&M and USGS-ARMI, with the majority of funding supplied by USGS-ARMI.

The surveys document species presence, distribution, and the location and number of breeding sites in watersheds distributed across the parks. The surveys included many areas where

amphibians have never been sampled or documented due to remoteness. Results provide a baseline for monitoring amphibian population trends that may be indicated by the net gain or loss of breeding populations over time.

All amphibian species in the Greater Yellowstone Ecosystem (GYE) are pond-breeding species, dependent on shallow, quiet water for egg deposition and larval development (Koch & Peterson 1995). Careful searches of these habitats during an appropriate time frame (egg deposition to metamorphosis) are thus likely to reveal the presence of amphibians if they occur in an area. Some reptiles of the GYE (i.e., the two gartersnake species) also frequent wetlands. The amphibian surveys thus also serve to document the presence of these species and any reptile species encountered en route to survey areas.

## Methods

To select watershed units and wetlands for sampling in 2002 and 2003, we implemented the following procedures. Using GIS (ArcView 3.2), we partitioned YELL into 10 rectangular blocks and GRTE into 5 blocks. Within each block, we randomly selected a catchment (watershed unit) for survey from a set of hierarchically nested drainage catchments provided by the USGS Elevation Derivatives for National Applications (EDNA) Project (<http://edna.usgs.gov>) and the EROS Data Center (Alisa Gallant). These catchments are generally a few square kilometers in size, similar to or smaller than the hydrological units (HUC 7th level) that we used for surveys in 2000 and 2001. If the selected catchment contained no potential amphibian breeding sites (ponds and wetlands), another catchment was randomly selected. If the selected catchment contained 10 or fewer potential breeding sites, adjacent catchments were added until 11-50 wetland sites were included, and this constituted the unit targeted for survey. Within the units, we identified potential amphibian breeding habitat (ponds, lakes, and wetlands) using National Wetland Inventory (NWI) and topographic maps. NWI sites with water regimes other than “temporarily flooded” and “saturated” were deemed potential amphibian breeding habitat. The coordinates of these pre-identified sites were loaded into GPS receivers to ensure positive identification of sites while in the field and for navigation purposes. Field crews were instructed to visit all pre-identified areas and to conduct surveys at any other sites encountered within the watershed unit that had potential habitat for pond-breeding amphibians: ponds, pools in moist or wet meadows, beaver impoundments, stream oxbows and backwaters. Surveys of all potential habitat were conducted where possible; sub-sampling was used in large blocks of habitat such as extensive wet meadows or flooded areas. In some watershed units, surveys were concentrated in the portion of the area where wetlands were clustered; due to time and safety constraints, field crews were instructed not to visit isolated wetlands at the far ends of catchments lacking trails.

We tested recently-developed wetland probability maps in 2003. Chris Wright at Montana State University provided a GIS layer showing 10 ‘wetland probability’ areas within 3 of the catchments targeted for surveys in 2003. These areas were not rated as wetlands by NWI.

We visited these polygons and conducted amphibian surveys if potential breeding sites (wetlands with surface water) were present.

Surveys followed standard amphibian visual encounter methodology (Thoms and Olson 1997). Field crews walked the perimeters of water bodies and transects through shallow ponds and wetlands. Long-handled dip-nets were used to sweep the water for amphibian larvae. At sites with restricted visibility due to vegetation or turbidity, field crews made regular net-sweeps (every 2 or 3 steps).

Data collected in the field included location recorded with a GPS receiver, time spent searching, species observed (specifying life stages and numbers of each), weather, habitat descriptors, water temperature, pH and conductivity (see Appendix II, Survey Data Sheet). Sites were also documented with drawings and photos, and species were documented with photographs of the various life stages. In 2002 and 2003, we used personal digital assistants (PDAs) to record data in four tables (Locations, Survey Data, Animal Observations, and Capture Data). The PDAs were programmed using forms software (Pendragon Forms 3.2), in consultation with USGS Rocky Mountain ARMI personnel (Sarah Street and Blake Hossack). Data collected in the PDA were the same as the fields on the data sheet (Appendix II), and site maps were hand drawn on forms (also in Appendix II). The PDA data were downloaded directly into a Microsoft Access database.

Survey work was conducted mainly by two-person field crews. In 2000 we had 1 crew (M. Legler, B. O'Hearn); in 2001, 2 crews (M. Chatfield, J. Jones, J. Bergstrom); in 2002, 2 crews (M. Chatfield, H. Cooper, G. Carnwath, C. Lockhart); in 2003, 2 crews (P. Barry, A. Pennell, C. Hume, M. Farmer). Field surveys were also conducted by volunteers (C. & D. Corkran, A. Harvey) and the project supervisor (D. Patla). Volunteer participation allowed us to complete 1 or 2 additional catchments per year. Survey work began in June (6/22/2000, 6/1/2001, 6/5/2002, 6/11/2003), and ended the first week in August. The survey season was designed with the objective of conducting surveys after egg deposition and before ponds dry up or metamorphosis is completed. To help determine survey season, some reference sites (mostly where monitoring has been conducted since the early 1990s) were checked starting in May. In 2002, about 18% of the survey sites were re-surveyed to collect data on detectability of species; and in 2003, 22%. Most revisits were conducted within about 1 week of the initial survey.

The field crew was lodged at Utah Dorm at Lake, which provided a convenient central location for operations at economical rates (<\$4 per night per person). Much of the work, particularly in 2002 and 2003, was conducted in remote backcountry areas. YELL and GRTE granted camping permits and multiple forms of assistance for planning and conducting backcountry work. GRTE provided fee waivers for campground camping. YELL and GRTE provided boat transport across Yellowstone and Jackson Lakes in 2002 and several nights of use of backcountry cabins (Fawn Creek Pass and lower Berry Creek). In 2003, Park support for transport across Yellowstone Lake to our study area was not available and we hired the concessionaire at Bridge Bay.

### *PAO*

Proportion of Area (or sites) Occupied (PAO) methodology (MacKenzie et al. 2002; Royle & Nichols 2003) provides a statistical framework for assessing changes in site occupancy (Baily et al. in press). Because it allows for analysis of how site variables (e.g., maximum water depth, vegetation type) or sampling variables (e.g., weather, date, time of day) affect detection probability, PAO is a considerable advance over simply enumerating changes in the number of breeding sites as a way to determine trends. Estimating detection probability (by recording the results of multiple visits to sites) enables estimates of PAO that are not biased. As a tool for calculating PAO, the program PRESENCE was developed by Darryl MacKenzie of Proteus Research & Consulting Ltd. under contract to U.S. Geological Survey, Amphibian Research and Monitoring Initiative (<http://edc2.usgs.gov/armi/>). PRESENCE is available at: <http://www.mbr-pwrc.usgs.gov/software/>. The program MARK (White & Burnham 1999) is also able to provide PAO and detection probability estimates: <http://www.cnr.colostate.edu/~gwhite/mark/mark.htm>

For this report, we used PRESENCE to calculate PAO and detection probability for 2002 and 2003. In 2002, 18% of the potential amphibian breeding sites were re-surveyed at least once, and 22% were re-surveyed in 2003. Most of the site revisits were conducted in YELL; few in GRTE. Our most intensive effort to collect detection data occurred in Hayden Valley, YELL in 2003. Of the 52 wetland sites surveyed in 2003, 30 sites were re-surveyed a 2nd time, 20 sites re-surveyed a 3<sup>rd</sup> time, and 13 sites re-surveyed a 4<sup>th</sup> time. We used random selection to pick sites for re-survey: after the first round of surveys, we wrote the names of qualifying sites (wetlands) on slips of paper and made a blind draw to select sites.

We are currently in the initial stages of using PAO methodology to analyze sampling and site covariates that may influence occupancy. Model building and testing will be investigated with the GRYE I&M staff (quantitative ecologist, Rob Bennetts).

## Results

### *Project Data*

We are working with I&M to compile a database containing all survey data and observation records (2000-2003) in coordination with USGS-ARMI. As of this writing, the data reside in three relational databases (2000-2001, 2002, and 2003); the 2003 database is submitted with this report. Please see Appendix III for additional information concerning the database.

Digital photographs of sites visited and voucher photos of amphibians are included on the CD submitted with this report. The Survey and Observation tables in the database provide the photo identification number, linking subjects to photos. ArcView GIS themes documenting the locations of sites and amphibian/reptile records are also on the CD.

### *Survey Targets*

In 2003, we conducted surveys in 7 catchments (also referred to as watershed units): 4 in YELL, 3 in GRTE (2 catchments plus a very small catchment adjacent to a catchment surveyed last year with few sites).<sup>1</sup> Considering all 4 years of this project (2000-2003), systematic or mid-level surveys/monitoring have been conducted in 32 randomly-selected catchments (19 in YELL; 13 in GRTE) and at over 600 sites, with wide distribution across the parks (Fig 1 and 2; Table 1A&B). Table 1 displays the number of potential sites visited per catchment per year and the number of wetland sites where amphibian surveys were conducted. Amphibian surveys were conducted only at sites where field crews found surface water that could provide amphibian breeding habitat. A substantial number of areas pre-identified as potential amphibian habitat were found to be unsuitable because they were dry; a few were too hot (i.e., hotter than 40°C). Unsuitable areas constituted about 29% of the pre-identified sites visited over the 4 year study. Drought in northwest Wyoming since 2000 likely reduced the number of suitable breeding sites, with variable effects on amphibian habitat among the catchments.

Our methodology focused on identifying breeding sites (eggs, larvae, or recent metamorphs present) because changes in the number of breeding sites are thought to best illustrate amphibian population trends (Green 1997). Numbers of breeding sites are used for the monitoring index that is being implemented by ARMI, the proportion of area occupied (PAO) (McKenzie et al. 2002). Focusing on breeding sites minimizes the problems of variable

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<sup>1</sup>Yellowstone is presented first in Results section, to follow the convention in previous reports of presenting results from north to south.

conspicuousness and closure. Unlike adults, amphibian larvae cannot leave a wetland site. Multiple surveys of sites provide an estimate of detectability relevant to each species, assuming the site is “closed” to species arrivals and departures after the first survey.

### ***Yellowstone***

In YELL from 2000 through 2003, surveys were conducted in 19 catchments (Fig.1), and at 466 sites (Table 1A). At least one amphibian (of any life stage) was found at approximately 70% of the sites surveyed (all years summed). Amphibians were found in all catchments.

Distribution of species among the catchments is summarized in Table 2 and shown on Figures 3-6. The most widely distributed species was the Columbia Spotted Frog, found breeding in 89% of the catchments (17 of 19) and present in all 19 catchments. This was followed by the Boreal Chorus Frog (breeding in 74% of the catchments, present in 84%); the Blotched Tiger Salamander (breeding in 58% of the catchments, present in 68%), and Boreal Toad (breeding in 26% of the catchments, present in 37%).

The number of breeding sites found each year per species, and the percent of surveyed wetlands that hosted breeding by each species are summarized in Table 3. (Breeding sites are identified by the presence of eggs, larvae, or recent metamorphs.) In all 4 years, relative abundance of the numbers of active breeding sites found per species was quite consistent despite the great variety of terrain sampled each year, with Boreal Chorus Frog breeding sites the most numerous, and Boreal Toad the least (Table 3). In 3 of the 4 years, more Columbia Spotted Frog breeding sites were found than Blotched Tiger Salamander breeding sites.

PAO estimates 2002-2003 (Table 4) for YELL provide occupancy rates (of breeding sites) that are unbiased by the variable detectability of species. Chorus frog breeding sites had high detectability (93% both years) and the highest PAO for both years in YELL (52 % and 37% site occupancy in 2002 and 2003). Tiger salamanders had the lowest detectability (62-63%), thus PAO for this species (21% and 28%, 2002 and 2003) was considerably higher than the naive observation rate (14% and 19%, 2002 and 2003). Spotted frogs had a variable detection probability (78% in 2002 and 95% in 2003). PAO for spotted frogs in 2002 (27%) was greater than salamanders but considerably lower than salamanders in 2003 (PAO spotted frogs 15% in 2003). Boreal Toads were encountered too rarely to provide meaningful detection rates (value of 1.0), hence naive observation rate and PAO are equivalent (4% and 2% occupancy rate in 2002 and 2003).

### **Hayden Valley**

A catchment between Trout Creek and Alum Creek in Hayden Valley (Sulphur Mountain area) was the subject of amphibian surveys as a pilot study in 2000, and in 2002 and 2003 (Table 4). These are the only data for multiple years of survey in the same catchment in the GYE. The data will assist us in model development for monitoring, in determining which factors most influence detectability, and in determining the optimum number of site visits.

### **Wetland Probability Maps**

Field crews visited 10 wetland probability polygons in each of 3 catchments: Hayden Valley, Calfee Creek, and Rocky Creek. The polygons varied in size from squares 60 m per side to irregular shapes up to 600 m per side. Most of the area covered by these polygons was dry, but searches within the approximate boundaries yielded a total of 15 wetland sites that were surveyed for amphibians. Ten of these sites were identified as breeding sites for amphibians (salamanders, chorus frogs, and spotted frogs).

## ***Grand Teton***

From 2001 through 2003, surveys were conducted in 13 catchments (Fig. 2). In the following summaries, we are not including the Kelly Warm Spring and Gros Ventre catchments. These 2 catchments lacked pre-identified potential amphibian breeding sites (except for one pond in the Kelly catchment) and were surveyed experimentally. In GRTE, we conducted surveys at 151 sites (Table 1). At least one amphibian (of any life stage) was found at approximately 42% of the sites surveyed, all years summed. This is much lower than the amphibian occupancy rates that we found in Yellowstone (70%). In 2 catchments, both on the upper east side of the Teton Range, no amphibians were found despite the existence of ponded water that appeared to provide potential breeding habitat.

Distribution is summarized in Table 2 and shown on Figures 3-6. The most widely distributed species was the Columbia Spotted Frog, found breeding in 73% of the catchments (8 of 11) and present in 82% (9 catchments). This was followed by the Boreal Chorus Frog (breeding in 64% of the catchments, present in 73%); the Blotched Tiger Salamander (breeding/present in 55% of the catchments), and Boreal Toad (breeding in 18% of the catchments, present in 27%).

The number of breeding sites found each year per species, and the percent of surveyed wetlands that hosted breeding by each species are summarized in Table 3. (Breeding sites are identified by the presence of eggs, larvae, or recent metamorphs.) Boreal Toad breeding sites were the least abundant in 2 of 3 years, and tied for last place with Blotched Tiger Salamander in 1 year. Boreal Chorus Frogs and Columbia Spotted Frog breeding sites each were the most abundant in 1 of 3 years, and tied for most abundant in 1 year.

PAO estimates for GRTE are provided in Table 4. However, given the small number of occupied sites and the small number of site re-surveys, detectability and PAO data are not very informative. For example, the low detection probability for chorus frogs in 2002 resulted from not detecting chorus frog tadpoles at only 2 sites in GRTE (and less than 8 tadpoles were seen at each of these sites on a previous or subsequent visit).

## **Discussion**

The past 4 years of surveys provide the first systematically-collected amphibian occurrence data in YELL and GRTE. This dataset can be used to analyze distribution and species co-occurrence patterns and to define habitat associations. It can serve as a basis for amphibian habitat modeling (e.g., USGS-EROS, Paul Bartelt) and testing wetland models (e.g., MSU and EROS, Chris Wright). As baseline information, the dataset can be used in the future to determine if amphibian populations are declining, holding stable, or increasing in the parks. In conjunction with habitat data and other sources of information (e.g., weather patterns, fish occurrence, wetland dynamics), it will also be possible to understand which factors contribute to amphibian population trends. We are working with NPS-I&M and USGS-ARMI to resolve questions about application of PAO methodology, site definition, sampling scheme and time frames, optimum number of site visits, special methods needed for monitoring Boreal Toads, and other issues.

## Targeted Species Surveys

### Background

As per our study plan for the NPS-GRYE inventory project, targeted species surveys were conducted to document the presence of amphibian and reptile species that were recorded historically, are expected to occur based on habitat and regional occurrence, or which have uncertain status. During the time frame 2001 through 2003, targeted surveys were conducted for the amphibian species Boreal Toad, Northern Leopard Frog, and spadefoot; and for the reptile species Northern Sagebrush Lizard, Rubber Boa, Eastern Yellow-Bellied Racer, Bullsnake, Valley Gartersnake, and Prairie Rattlesnake.

### Amphibians

#### *Boreal Toad*

Boreal Toads are of special concern because of potential declines in GRTE and YELL (Koch & Peterson 1995) and because toads in wild populations (e.g., in Colorado) appear to be vulnerable to devastating disease outbreaks due to a parasitic chytrid fungus (Muths et al. 2003). Chytrid disease was found to be prevalent among Boreal Toads of the National Elk Refuge in Jackson Hole in 2003 (Patla 2004).

For Boreal Toads, the focus of targeted surveys was to determine if previously-identified breeding sites remain occupied and active. The locations of active breeding sites documented 2000 through 2003 are shown in Figure 7.

2000: YELL, 5 sites were checked, 4 were active. In GRTE/JODR, 4 sites were checked, 4 were active.

2001: In YELL, 6 sites were checked, 5 were active. In GRTE/JODR, 5 sites were checked, 4 were active.

2002: In YELL, 12 sites were checked, 8 were active. In GRTE/JODR, 3 sites were checked, 2 were active.

2003: In YELL, 9 sites were checked; 7 were active. In GRTE/JODR, 5 sites were checked, 5 were active.

Of special interest in 2003 was the Snake River Pit toad breeding site in JODR. The gravel pit area was subject to extensive disturbance (grading with heavy equipment, uplands and ponds) for wetland restoration. The toad breeding site itself, however, was left mostly undisturbed; shorelines of northeast side of the northwest pond were not graded and neither was the stand of willows to the north. Toads returned to the pond and deposited eggs at or near former locations, and some tadpoles successfully reached metamorphosis.

Breeding sites for 7 previously-undocumented toad populations were found during surveys in randomly selected catchments 2001-2003 (Table 1): Boundary Cr., Fawn Cr., Heart River, Nez Perce Cr, and upper Duck Cr in YELL; Snake River upstream and downstream of Jackson Lake in GRTE.

#### *Northern Leopard Frog*

Leopard frogs were documented by museum collection in the 1950s in GRTE south of Jackson Lake at Jenny Lake (year 1954), String Lake (1951), and a pond or lake east of Bearpaw Bay (1939, "Beaver Dick Lake") (GYE historical database, Idaho State University; Koch & Peterson 1995). The herpetologist Charles Carpenter reported that leopard frogs were common

along the grass-sedge shores of String Lake in 1951, “closely associated at times with *Rana p. pretiosa*” [spotted frogs] (Carpenter 1953). No records exist for leopard frogs in GRTE after 1954, and Koch and Peterson (1995) thought it likely that leopard frogs were extinct in GRTE, based on the lack of records and the failure of searchers to find this species in the first half of the 1990s. However, after the field guide was published, one individual leopard frog was documented (with photograph) by a park naturalist near Flagg Ranch in 1995 or 1996. This is the only confirmed sighting since the 1950s to our knowledge. GRTE has received a number of observation reports from park staff and visitors since the mid 1990s, at areas including Snake River gravel pits, Bearpaw Lake, String Lake, Schwabacker Landing, Polecat, and Leigh Lake. However, none of these sightings has been confirmed (to our knowledge). Columbia Spotted Frogs, which may be confused with leopard frogs, are present at all these areas.

In YELL, there are no historical or recent confirmed observations of leopard frogs. Koch and Peterson (1995) mention a report of a sighting from the Bechler region in 1992. The presence of leopard frogs on the Henry’s Fork of the Snake River downstream of the park suggests that they could possibly occur in southwest YELL.

No leopard frogs were found in GRTE or YELL during surveys 2000-2003, and we are aware of no verified reports since 1996.

Leopard frog searches. These searches were conducted during this project in areas where leopard frogs were documented historically or reported recently. Details of the surveys (dates, times, locations, conditions, and other species found) are recorded in the databases, identified by “leopard frog search” in the Project field (survey table).

2000

Southeast side of Leigh Lake (7/24/2000)

West side of String Lake and large wetland to west (7/24/00)

North side of Snake River and wetlands from Flagg Ranch area to large wet meadows 1km southwest of Polecat Cr confluence (7/27/00)

String Lake (8/3/00)

Beaver Dick Lake (8/5/00)

Bearpaw Lake (8/5/00)

Grassy Lake Road wetlands and backwater pools on Snake River (8/9/00)

2001

Amphibian surveys in Polecat Creek watershed (7/5, 7/6, and 7/17/01).

2002

Amphibian surveys at Bearpaw-Trapper Lake and wetlands in catchment (6/17 - 6/21/02)

String Lake (6/21 and 8/6/02)

In YELL, Falls River catchment and Bechler Meadows wetlands (7/8 - 7/16. The field crew spent two extra days in the area to search 12 wetland sites in Bechler Meadows for leopard frogs following survey of the Falls River catchment.)

2003

Flagg Ranch area-Snake River (7/3, 8/5, 9/3/03)

### *Spadefoot*

Two unconfirmed observations of *Spea intermontana* or *S. bombifrons* are reported for YELL in Koch and Peterson (1995). Searches for spadefoots were conducted on Fairy Creek downstream of Fairy Falls in 2002 (June 21 and Aug. 6), in the vicinity of the last reported observation (1982). No spadefoots have been found during targeted searches or encountered during surveys, and no observations have been reported (to our knowledge). Spadefoots thus remain unconfirmed in YELL.

### **Reptiles**

Searches for Northern Sagebrush Lizard, Rubber Boa, Eastern Yellow-Bellied Racer, Bullsnae, and Prairie Rattlesnake were concentrated in lower elevations portions of YELL (northwest corner) and thermal areas, in the vicinity of historical and more recent observations. Reptile observation locations are shown on Figure 8.

2001. Searches for snakes were conducted in known and suspected rattlesnake den areas in YELL. Two active rattlesnake dens were documented in northwest Yellowstone, at Stephens Creek and Rattlesnake Butte. Sagebrush lizards were documented in Norris Geyser Basin, Yellowstone River Trail, Rattlesnake Butte, Black Canyon, and Lone Star Geyser Trail. Searches for Rubber Boas in the Tetons where they have been observed previously (Death Canyon) yielded observations of Intermountain Wandering Gartersnakes but no boas.

2002. Visual encounter surveys for reptiles were conducted in suitable habitat at selected areas, including: Yellowstone River Trail near the northern boundary of YELL, Washburn Hot Springs, Lone Star Geyser area, Norris Geyser Basin, and the Stephens Creek area. Bullsnaes were observed at two sites near the Yellowstone River in northern Yellowstone, elevation 1650 m (5420 ft). Northern Sagebrush Lizards were observed at 12 sites, in Norris Geyser Basin (1 site) and near the Yellowstone River at 1650 m elevation. No reptiles were found in surveys of the Washburn Hot Springs area, where Rubber Boas and Northern Sagebrush Lizards were recorded in the 1970s. In a search of the Lone Star Geyser area, where a Valley Gartersnake was reported in 1992, only one Intermountain Wandering Gartersnake was found. During amphibian surveys, Valley Gartersnakes were recorded at 5 sites, clustered in two areas: the southwest corner of YELL and near the southern border of JODR. The Intermountain Wandering Gartersnake was documented at 44 sites in YELL and GRTE in 2002 during amphibian surveys.

### 2003

Surveys for reptiles were conducted at sites in northwest Yellowstone. The Intermountain Wandering Gartersnake was documented at 11 sites in YELL and GRTE in 2003 during amphibian surveys.

### **Summary**

#### *Amphibians*

Northern Leopard Frogs remain unconfirmed in YELL, as do spadefoots. In GRTE, leopard frogs have not been confirmed since the 1950s; but there was one documented sighting in JODR in about 1996. No leopard frogs have been found on targeted surveys, and occasional reports of leopard frogs have not been supported with evidence (to our knowledge). Due to

possible confusion with spotted frogs, leopard frog sightings must be documented with photos or collection, or reported by persons who are familiar with both species and can provide detailed and convincing descriptions of the observed frog(s). Searches for leopard frog breeding sites should be conducted in the vicinity (within at least 0.5 km) of documented or credible sightings of adults or juveniles.

Survey and monitoring work since 2000 establishes that Boreal Toads are the least abundant of the GYE's native, wide-ranging amphibian species (i.e. tiger salamanders, chorus frogs, and spotted frogs). Since 2000, the finding of new populations and the persistence of breeding at previously-identified sites suggest that the species is not declining. However, we remain concerned about disease and the potential for rapid declines (as described in Muths et al. 2003). The status of Boreal Toads and other amphibian species in YELL and GRTE will be summarized in a synoptic report we are preparing for GRYE-I&M in 2004.

### *Reptiles*

Figure 8 displays the locations of reptile observations obtained during targeted reptile surveys and incidentally (mostly during amphibian surveys). The most widespread and frequently-observed reptile species in YELL and GRTE is the Intermountain Wandering Gartersnake. Observations occurred between 1590 m (5220 ft) and 2430 m (7970 ft) elevation. Valley Gartersnake occurred in two areas: the southwest corner of YELL and near the southern border of JODR. Valley Gartersnakes were documented in these two areas historically (1950s and 1970s, Peterson & Koch 1995). Rubber Boa sightings have been few since 2000. An injured and moribund boa was found and collected near Canyon in 2000 by a ranger (K. Gad). Two rubber boas were reported on Mt. Sheridan in YELL, one at an elevation of 3142 m (10,308 ft). Rubber Boas were reported in GRTE at Death Canyon, which Koch and Peterson (1995) refer to a "hotspot" for this species, and in Avalanche Canyon. The Eastern Yellow-Bellied Racer remains unconfirmed in YELL, but we think it is possible or likely that it will again be seen in the Yellowstone River canyon if searches continue. Bullsnares (a subspecies of gophersnake) are known from sites near Mammoth, along the Gardiner road, and in the Yellowstone River canyon in northern YELL. Gophersnakes remain unconfirmed in GRTE. Prairie Rattlesnakes are confined to low elevations in the northwest corner of YELL; the highest elevation occurrence we recorded was 1755 m (5760 ft). Two den sites were located or confirmed in 2001. Northern Sagebrush Lizards have been observed in YELL since 2000 at Norris Geyser Basin and near the Yellowstone River at 1650 m elevation. In GRTE, an observation of 5 sagebrush lizards was reported to the park in July of 2003, at the Pilgrim Cr parking area (S. Wolff, pers comm). This is near the area where they were documented historically (1965) and in 1992 (Koch & Peterson 1995).

## **Lodge Creek Apex Site**

### **Background**

Under ARMI, a small number of selected areas in a region are designated as “apex” (formerly called “sentinel”) sites, where intensive population studies are conducted. Types of studies that are conducted at apex sites include investigation of demographic and life history characteristics of key species, the relation of environmental change to changes in demographic and life history characteristics over time, cause-effect of population changes, and protocol and technique development (USGS-ARM I 2001).

The Lodge Creek area (Fig. 9) serves as an apex site in the GYE-ARM I project. Work in 2000-2003 was funded by ARMI, supplemented by donated time (D. Patla). The Columbia Spotted Frog population of the Lodge Creek area was studied intensively during the years 1953-55 (Turner 1960), and again 1993-95, with continued monitoring since 1995 (Patla 1997; Patla & Peterson 1999). Research in the mid 1990s revealed that the population had declined sharply (about 70-80%) since the 1950s. Continued monitoring of the site allows study of life history, demographic characteristics, and habitat use patterns over time, and observation of responses of the population to annually fluctuating weather and human activities (e.g., fuel hazard reduction and residential development in the area). It allows us to work with resource managers to apply mitigation measures. We hope to apply and test the technique of photo-identification as a means of population size estimation. Previous and current research contributes to an understanding of how human-caused habitat modifications may contribute to population decline. A scientific paper on research at Lodge Creek is in preparation.

### **Methods**

In 2003, as in the previous 3 years, we conducted breeding-site monitoring and capture/recapture work (using photo identification) within occupied habitat (breeding, foraging, and wintering sites). The area was visited on 11 occasions between May 13 and October 6, with some occasions consisting of up to 3 days of field work. Capture/recapture-photography was conducted in the main study area (north of the highway) in 3 sessions on 7/14-16, 8/6-8, and 8/26-28/2003. At lower Lodge Creek and lagoon, young of the year (+100 frogs) were caught and examined to estimate the proportion of the cohort showing abnormalities. Water samples were collected for USGS at the Pool 3 breeding site in 2001, 2002, and 2003. Following the outbreak of frog abnormalities, water samples for USGS were collected at upper Lodge Creek and at the mouth of Lodge Creek in Sept. 2003.

### **Results and Discussion**

Figure 9 depicts the study area. A summary of monitoring results in terms of reproductive effort 2000-2003 is provided in Table 5. Three breeding areas were active during the time period: an ephemeral pool in the forest (Pool 3), a wet meadow at the edge of the residential area (FHA wetland), and in the lagoon at the mouth of Lodge Creek (south and north ends) (Fig. 9). The total number of egg masses appeared to be declining 2000-2002, but in 2003 the total number of egg masses (>80) increased sharply relative to previous years. The FHA wetland (wet meadow next to Federal Highway Administration housing in the residential area) produced the highest number of egg masses on record (about 17 masses). However, this site appears to be a sink for reproduction, with the wetland drying up too fast to allow successful metamorphosis; no successful reproduction has occurred during the past 3 years. At Pool 3 (historical breeding site identified by Fred Turner

in the early 1950s), reproductive effort in terms of egg masses has been fairly consistent over the past 3 years. Summer rainfall (and its timing) was adequate to maintain sufficient water (but just barely) for metamorphosis to occur in 2002 and 2003. Size at metamorphosis was smaller than in 2002, but numbers of tadpoles and metamorphs appeared to be much higher.

At the lagoon, reproductive effort was very high in 2003 (48 egg masses at the south end, 9 egg masses at the north end) and metamorphosis apparently abundant. However, nearly the entire young-of-the-year cohort (>90% of 100 froglets examined in Aug-Sept) were abnormal. Symptoms included: inflamed swelling and multiple bumps at the site of tail resorption (urostyle); bodies and upper hind legs grossly swollen; belly and hind legs flushed red; hard dark bumps visible under the skin of belly and back. Symptoms first appeared in early August. No dead frogs were found during this outbreak, and the affected frogs appeared to be vigorous and lively despite the affliction. We have seen nothing similar to this previously, anywhere in the GYE. See Appendix IV for full report and photos.

Six frogs with these symptoms were collected live and sent to USGS Wildlife Health Center at Madison WI. David E. Green diagnosed the lumps in the skin around the urostyle as encysted metacercaria (immature flukes). He noted that the location suggests that the parasites originally were in the skin and muscle of the tail; when the tails were resorbed during metamorphosis, the parasites clumped at the tip of the urostyle. Parasitologists at the NWHC identified the family of metacercaria as Diplostomatidae, which commonly parasitize fish. The swelling in the frogs may have been due to blockage of the lymph hearts on each side of the urostyle, resulting in fluid accumulation under the skin. Alternatively, a virus could have been the cause of the bloating and redness.

In the main study area in 2003, 79 frogs were captured and photographed in the initial capture period (July 14-16/03); 70 frogs in the second capture period (8/6-8/8/03); and 57 frogs in the third capture period (8/26-28/03). Data are summarized in Table 6. Adult population size estimates are pending, and will be based on analysis of the digital photos of individual frogs to ascertain recapture rates.

The number of juveniles as a percent of the population was highest in 2000 (50-52%), declining to 25-36% in 2001 and 6-8% in 2002 (Table 6). In 2003 the downward trend ended, with juveniles constituting 12-16% of the captured frogs. Reductions in the juvenile class probably reflects poor recruitment in the drought years of 2000-2002. Given the numbers of metamorphs at Pool 3 in 2003 (Table 5), the juvenile component of the population may rise in 2004 unless winter mortality (2003-2004) is high.

Among adults, females were consistently less numerous than males in 2000 and 2001, but more numerous than males in 2002-2003 (Table 6). The latter is thought to be the more normal situation for spotted frog populations; e.g., females predominated in the population in Turner's studies of the 1950s and in our study of the 1990s. Males had a consistently lower mean weight-length ratio than females in all years. Mean weight-length ratios of adult males and females were similar for males and females in 2002 and 2003, but were lower for females and slightly lower for males in 2001. Statistical tests have not yet been performed to determine if differences are significant. Possibly, weight-length ratios can inform us about the condition of frogs, allowing us to test hypotheses about the effects of seasonal weather patterns; e.g., the ratio should be higher in moist, warm years than in cold, dry years.

Some changes in habitat use patterns have occurred over the past 4 years. In 2003, the number of frogs (in numbers and as a percent of the captured frogs) declined in the fenced spring area at the head of the Lodge Creek. For example, 34-38% of the captured frog sample were

obtained in the fenced area in late Aug/early Sept 2001 and 2002. However, in August 2003, few frogs were seen in the fenced area, and only 19% of the sample was caught there. The fenced springs and associated wet features have supported a large portion of the main study area frog population in all years since my study began in 1993 (Patla 1997). In 2003, there was little surface water in the area; several features normally holding water were completely dry. In addition, an unprecedented (relative to 1993-2002) amount of surface disturbance occurred when maintenance workers cut and dragged large trees around the springs in late July 2003, where frogs are usually concentrated. One of the few remaining pools of water was filled with debris (branches and needles). Possibly, many of the frogs that would normally be present around the springs had abandoned the area due to scarcity of water, thus it is hoped that mortality was limited during the unannounced tree-removal project. Surface water has declined progressively over the past 4 years of drought; 2003 brought the driest conditions I have seen since initiating my research in 1993. The spring where frogs congregate to overwinter was reduced in 2003 to barely a fist-sized pool of water, and stream levels were very low in autumn 2003. Cold temperatures and low water levels over the winter could result in high mortality during over-wintering.

Another habitat use change that evolved over the past 4 years was the increasing number of frogs and egg masses in the wet meadow next to FHA housing. Premature drying of this area (even faster than Pool 3 and 4) results in apparently low habitat quality. It seems unlikely that use will persist unless summers become substantially wetter in the near future.

Other habitat use patterns appeared to be similar over the 4 years. Spotted frogs continued to be absent or very scarce from the portion of Lodge Creek within the horse pasture, but occupied other stream segments upstream of the highway. Breeding by frogs did not occur at the pool in the horse pasture meadow; the last use of this historical breeding site by spotted frogs was in 1994.

The results of water sampling at Pool 3 and Lodge Creek are provided in Table 7. Pool 3 has high levels of UVA compared to other sites in the Rocky Mountains that are sampled by USGS. This may be the result of high levels of DOC (dissolved organic carbon) in the forest soil (D. Campbell, USGS, pers. comm).

The Lodge Creek spotted frog population is the only amphibian population in YELL for which there are historical data on population size and habitat use. Lodge Creek has been the most consistently monitored amphibian site in the GYE over the past decade; the only site where surveys are sufficient to document annual fluctuations in reproductive effort and population structure. We hope to continue monitoring in 2004.

## **Amphibian Disease and Mortality**

Dead and diseased amphibians are of interest because of the role disease may be playing in amphibian population declines (Daszak et al. 1999). In 2001, 2002, and 2003, we collected dead amphibians encountered during surveys and froze them or preserved them in ethanol. Specimens collected in 2002 and 2003 at various sites in GRTE and YELL are detailed in Appendix IV. These specimens were sent to the National Wildlife Health Center (NWHC) in October 2003.

Preliminary results summarizing diagnostic findings for 2001 specimens and some 2002 specimens were provided by NWHC (Appendix IV); a formal final report from NWHC is still pending and expected soon. Two major diseases have been detected in YELL: ranavirus and chytrid fungal infection. Specimens from the Columbia Spotted Frog mass mortality event (discovered by Kendra Kinnan) that occurred in July-Sept 2002 along a stream north of the Fishing Bridge sewage treatment facility were diagnosed as having both ranavirus and chytrid infections, with ranavirus considered the cause of death.

## References Cited

- Bailey, LL., T.R. Simons, and K.H. Pollock. In press. Estimating site occupancy and species detection probability parameters for terrestrial salamanders. *Ecological Applications*.
- Carpenter, C.C. 1953. An ecological survey of the herpetofauna of the Grand Teton-Jackson Hole area of Wyoming. *Copeia* 1953 (3): 170-174.
- Crother, B.I. (Chair, Joint Committee on Standard English and Scientific Names) 2001. Scientific and standard English names of amphibians and reptiles of North America north of Mexico, with comments regarding confidence in our understanding. *Herpetological Circular Number 29*, Society for the Study of Amphibians and Reptiles. Web page version: <http://www.herpllit.com/SSAR/circulars/HC29/names.html>.
- Daszak P., Berger, L., Cunningham, A. A., Hyatt, A. D., Green, D. E. and Speare, R. 1999. Emerging infectious diseases and amphibian population declines. *Emerging Infectious Diseases Journal* [serial online] 1999 Nov-Dec 5(6). Available from: URL: <http://www.cdc.gov/ncidod/EID/vol5no6/daszak.htm>.
- Fellers, G.M. 1997. Design of amphibian surveys. P. 23-34 *in* Sampling Amphibians in Lentic Habitats. D.H. Olson, W.P. Leonard, and R..B. Bury, eds. Northwest Fauna 4. Society for Northwestern Vertebrate Biology, Olympia, WA.
- Green, D.M. 1997. Perspectives on amphibian population declines: defining the problem and searching for answers. Pp. 291-308 in *Herpetological Conservation*, Vol I. Amphibians in decline. Canadian studies of a global problem, DM Green, editor. Society for the Study of Amphibians and Reptiles, St. Louis, MO.
- Koch, Edward D., and Charles R. Peterson. 1995. *Amphibians and Reptiles of Yellowstone and Grand Teton National Parks*. Salt Lake City: University of Utah Press.
- McKenzie, DI, Nichols JD, Lachman GB, Droege S, Royle JA, Langtimm CA. 2002. Estimating site occupancy when detection probabilities are less than one. *Ecology* 83(8): 2248–2255.
- Muths, E., P.S. Corn, A.P. Pessier, and D.E. Green. 2003. Evidence for disease related amphibian decline in Colorado. *Biological Conservation* 110: 357–365.
- Patla, D.A. 1997. Changes in a population of spotted frogs in Yellowstone National Park between 1953 and 1995: the effects of habitat modification. M.S. thesis, Idaho State University
- Patla, D.A. 2001. Status and trends of amphibian populations in the Greater Yellowstone Ecosystem: progress report, 2001, submitted to Rocky Mountain Regional Coordinator, USGS Amphibian Research and Monitoring Initiative.

- Patla, D.A. and C.R. Peterson. 1999. Are amphibians declining in Yellowstone National Park? *Yellowstone Science* 7(1): 2-11.
- Patla, D.A., and C.R. Peterson. 2002. Amphibian and Reptile Inventory and Monitoring, Grand Teton & Yellowstone National Parks, 2001. Report submitted to USGS-ARMI and NPS.
- Patla, D.A., and C.R. Peterson. 2003. Amphibian and Reptile Inventory and Monitoring, Greater Yellowstone Network, Grand Teton & Yellowstone National Parks. Progress Report, 2002. Report submitted to USGS-ARMI and NPS.
- Royle, J.A. and J.D. Nichols. 2003 Estimated abundance from repeated presence-absence data or point counts. *Ecology* 84(3): 777–790.
- Thoms, C, C. C. Corkran, and D.H. Olson. 1997. Basic amphibian survey for inventory and monitoring in lentic habitats. *In* Sampling Amphibians in Lentic Habitats. D.H. Olson, W.P. Leonard, and R..B. Bury, eds. Northwest Fauna 4. Society for Northwestern Vertebrate Biology, Olympia, WA.
- Turner, F.B. 1960. Population structure and dynamics of the western spotted frog, *Rana p. pretiosa* Baird & Girard, in Yellowstone Park, Wyoming. *Ecol. Monographs* 30(3):251-278.
- USGS ARMI Task Force. 2001. Conceptual design and implementation guidance for the Amphibian Research and Monitoring Initiative. Draft, May 11, 2001.
- White, G.C. and K. P. Burnham. 1999. Program MARK: Survival estimation from populations of marked animals. *Bird Study* 46 Supplement, 120-138.

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Field crews are asked to perform a large amount of work compressed into a short field season, under unpredictable and sometimes harsh conditions. The outstanding field crew of 2003 consisted of: Pete Barry (field crew leader), Meridy Farmer, Colin Hume, and Anja Pennell. Char and Dave Corkran again traveled from Portland to volunteer their expert services for backcountry amphibian surveys in Calfee Creek and at sites elsewhere in Yellowstone; this was their 7<sup>th</sup> consecutive year of amphibian survey work in the GYE. Ann Harvey of Wilson, WY also volunteered for a second year and was a valued crew member in 3 of the catchments in 2003.

At Idaho State University, Pam Christensen, Cat Hjelm, Sandy Mitchell, Connie Peck, and Mary Ann Stoll assisted with paperwork, supplies acquisition, and personnel matters. Merlin Hare helped prepare the figures, compiled the report into digital format, and provided technical and computer support throughout the project.

Table 1A. Catchments and numbers of sites sampled in YELL.  
 "Breeding" & "Non" columns list the number of active breeding sites per species & the number of other sites where the species was observed.  
<sup>1</sup> Surveys incomplete for this unit; too late in season

Year	Park	Unit	ID	Number of sites visited	Sites Surveyed (suitable)	Total sites surveyed (all years)	Sites occupied	Tiger Salamander		Boreal Toad		Boreal Chorus Frog		Columbia Spotted Frog	
								Breeding	Non	Breeding	Non	Breeding	Non	Breeding	Non
2000	YELL	Arnica	292	19	10		6	0	0	0	0	5	0	0	2
2001	YELL	Arnica	292	6	6		5	0	0	0	0	0	0	2	3
total	YELL	Arnica	292			16									
2002	YELL	Boundary Cr	1092	28	22	22	20	1	1	4	1	7	6	1	0
2000	YELL	Buffalo Meadows	302	30	17		17	2	0	0	0	7	3	6	6
2001	YELL	Buffalo Meadows	302	17	10		9	5	1	0	0	6	1	6	3
total	YELL	Buffalo Meadows	302			15									
2003	YELL	Calfee	630	42	31	31	15	4	3	0	0	0	0	5	9
2001	YELL	Chipmunk <sup>1</sup>	494	19	12	12	5	0	0	0	0	0	2	0	5
2002	YELL	Delusion South <sup>1</sup>	1207	16	9	9	9	2	3	0	0	9	0	1	0
2002	YELL	Falls River	1436	36	25	25	16	0	0	0	0	5	1	10	4
2002	YELL	Fawn	214	32	20	20	14	2	1	2	7	3	6	5	4
2001	YELL	Frost Lake	238	36	29	29	17	0	0	0	0	0	0	6	11
2001	YELL	Grebe Lake	170	50	47	47	40	0	1	0	0	25	9	6	4
2000	YELL	Hayden	245	54	54		45	9	6	0	5	28	9	7	15
2002	YELL	Hayden	245	50	44		43	14	3	0	7	36	4	9	4
2003	YELL	Hayden	245	60	52		52	23	3	0	2	45	6	9	5
total	YELL	Hayden	245			54									
2003	YELL	Heart	1451	35	26	26	15	1	0	3	2	6	2	5	4
2001	YELL	Nez Perce	259	44	26	26	12	2	0	2	0	3	1	3	7
2001	YELL	Pelican <sup>1</sup>	271	30	17	17	11	1	0	0	0	9	0	5	4
2001	YELL	Pleasant Valley	91	31	16	16	11	0	0	0	0	1	1	4	5
2003	YELL	Rocky	1221	65	41	41	8	0	0	0	1	0	0	2	6
2002	YELL	Slough Cr	271	28	15	15	8	2	0	0	0	0	3	2	3
2000	YELL	Specimen	29	54	37	37	16	0	1	0	0	5	1	5	9
2001	YELL	Upper Duck Cr	167	10	8	8	4	1	0	1	1	5	1	0	1
YELL totals						466	398								



**Table 2. Amphibian species distribution summary**  
YELL, 19 catchments surveyed; GRTE, 11 catchments surveyed

Species	YELL, number of catchments breeding	YELL, percent of catchments breeding	YELL, number of catchments found	YELL, percent of catchments found	GRTE, number of catchments breeding	GRTE, percent of catchments breeding	GRTE, number of catchments found	GRTE, percent of catchments found
B. Tiger Salamander	11	58%	13	68%	6	55%	6	55%
Boreal Toad	5	26%	7	37%	2	18%	3	27%
Boreal Chorus Frog	14	74%	16	84%	7	64%	8	73%
Columbia Spotted Frog	17	89%	19	100%	8	73%	9	82%

Table 3. Summary of YELL & GRTE survey results, 2000 through 2003: catchments sampled, potential amphibian breeding sites surveyed, numbers of breeding sites per species per year, and the percentage of surveyed sites where species bred.

Year	Number of catchments	Number of sites surveyed	<u>Tiger Salamander</u>		<u>Boreal Toad</u>		<u>Boreal Chorus Frog</u>		<u>Columbia Spotted Frog</u>	
			Breeding sites	Percent	Breeding sites	Percent	Breeding sites	Percent	Breeding sites	Percent
<b>YELL</b>										
2000	4	118	11	9.3%	0	0.0%	45	38.1%	18	15.3%
2001	9	171	9	5.3%	3	1.8%	49	28.7%	32	18.7%
2002	6	134	19	14.2%	6	4.5%	65	48.5%	29	21.6%
2003	4	150	28	18.7%	3	2.0%	51	34.0%	21	14.0%
Total	19									
Mean			16.8	11.9%	3.0	2.1%	52.5	37.3%	25.0	17.4%
standard error			4.3	0.029	1.2	0.009	4.3	0.042	3.3	0.017
<b>GRTE</b>										
2000	0									
2001*	5	63	4	6.3%	3	4.8%	14	22.2%	9	14.3%
2002	4	49	3	6.1%	3	6.1%	5	10.2%	8	16.3%
2003	3	39	2	5.1%	1	2.6%	5	12.8%	5	12.8%
		<b>151</b>								
Total*	11									
Mean			3	5.9%	2.3	4.5%	8.0	15.1%	7.3	14.5%
standard error			0.6	0.004	0.7	0.010	3.0	0.036	1.20	0.010

\*not including Gros Ventre & Kelly Warm Spring units

Table 4. Proportion of Area Occupied (PAO) and detectability estimates.  
 PAO provided by program Presence, single season model, with constant p & bootstrapped standard errors.  
 Abbreviations: Amti=Blotched Tiger Salamander; Bubo=Boreal Toad;  
 Psma=Boreal Chorus Frog; Ralu=Columbia Spotted Frog  
 1\* Revisits or sites too few for assessment of detection probability

Species	Study Area	Year	Naïve Observation Rate	PAO	standard error	Detection Probability
Amti	<i>YELL</i>	2002	0.14	0.21	0.214	0.62
	<i>YELL</i>	2003	0.19	0.28	0.057	0.63
	<i>Hayden, YELL</i>	2002	0.32	0.43	0.170	0.67
	<i>Hayden, YELL</i>	2003	0.44	0.53	0.085	0.69
	<i>GRTE</i>	2002	0.06	0.08	0.294	0.69
	<i>GRTE</i>	2003	0.05	0.05	0.034	1*
Bubo	<i>YELL</i>	2002	0.04	0.04	0.018	1*
	<i>YELL</i>	2003	0.02	0.02	0.012	1*
	<i>Hayden, YELL</i>	2002	<i>no breeding sites</i>			
	<i>Hayden, YELL</i>	2003	<i>no breeding sites</i>			
	<i>GRTE</i>	2002	0.06	0.06	0.035	1*
	<i>GRTE</i>	2003	0.03	0.03	0.026	1*
Psma	<i>YELL</i>	2002	0.49	0.52	0.051	0.93
	<i>YELL</i>	2003	0.35	0.37	0.043	0.93
	<i>Hayden, YELL</i>	2002	0.84	0.95	0.070	0.88
	<i>Hayden, YELL</i>	2003	0.88	0.91	0.047	0.95
	<i>GRTE</i>	2002	0.10	0.24	0.390	0.39
	<i>GRTE</i>	2003	0.13	0.13	0.054	1*
Ralu	<i>YELL</i>	2002	0.22	0.27	0.062	0.78
	<i>YELL</i>	2003	0.14	0.15	0.032	0.95
	<i>Hayden, YELL</i>	2002	0.23	0.29	0.139	0.73
	<i>Hayden, YELL</i>	2003	0.17	0.18	0.054	0.94
	<i>GRTE</i>	2002	0.16	0.23	0.095	0.69
	<i>GRTE</i>	2003	0.13	0.13	0.054	1*
			Number of sites surveyed	Number of Sites resurveyed		
			<i>YELL</i>	2002	134	25
			<i>YELL</i>	2003	150	36
			<i>Hayden, YELL</i>	2002	44	13
			<i>Hayden, YELL</i>	2003	52	29
			<i>GRTE</i>	2002	49	9
			<i>GRTE</i>	2003	39	5

Table 5. Results of monitoring Columbia Spotted Frogs at the Lodge Creek site.

	2000	2001	2002	2003
<b>Number of egg masses</b>				
Pool 3 (main study area)	14	7	9	10
FHA meadow	(unknown)	6	11	17 ( $\pm 2$ )
Lagoon	35-40	30	21	57 ( $\pm 2$ )
<b>Date of egg deposition</b>				
Pool 3	5/15-5/27	5/15-5/21	5/18-5/25	5/23-25
FHA meadow	(unknown)	mid May	5/19 & later	5/23-27
Lagoon	5/15-5/19	about 5/21	about 5/20	5/21-26
<b>Pools dry?</b>				
Pool 1	About 7/12 (est)	By 7/9/01	Last visit 7/4, still had water	Before 7/14
Pool 4	By about 8/20	By 8/3/01	By 9/4	Before 8/25
Pool 3	About 8/10	By about 8/20/02, then slightly replenished & dry again by 8/31	Persists, but very small by early July, then replenished by rain	About 8/23
FHA meadow	(unknown)	By 8/3/01	By 7/27 only 1 pool (2.5 x 2 m)	By 7/29
Lagoon	Persists	Persists	Persists	Persists
<b>Metamorphosis?</b>				
Pool 3	Probably none	Scant. Max number seen: 10 on 8/23. Mean SUL: 14.3 mm (se= .009)	More than expected given small numbers of tadpoles seen. first one seen 7/27. 32 meta on 8/1, 20 meta on 8/13. Mean SVL: 19.3 (n=26, se=0.267)	Approx 150 on 8/6; mean SVL 15.2 (n=11; se=0.36). 250-350 late stage tadpoles.
FHA meadow	?	None.	1 on 8/2	None
Lagoon	Some. <30 found on 8/28	Max number seen: 33, and seen consistently on 4 visits, 8/9 to 9/14/01. Mean SUL= 27.8 (se= .009)	Max number seen: 40 on 9/12. Mean SVL: 30.2 (n=27; se=0.302)	About 90 seen on 8/8; 150 on 9/3-9/4, mean SVL 26.7, n=39, 0.215. Most have swelling from parasites.

Table 6. Lodge Creek capture results, 2000-2003.

**Capture Results****2000**

	<b>First Capture (7/18-7/19/00)</b>			<b>Second Capture (8/23-8/25/00)</b>		
	146 total		146	129 total		129
	<b>Juvenile</b>	<b>Females</b>	<b>Males</b>	<b>Juv</b>	<b>Females</b>	<b>Males</b>
Number Caught	73	32	41	67	26	36
Percent juv/female/male	50%	22%	28%	52%	20%	28%
Mean SUL (mm)	37.9	56.5	51.3	39.2	59.2	53.9
SUL, SE	0.45	1.46	0.44	0.40	1.65	0.59
Min. SUL	29.6	46.1	42.2	32.6	49.1	46.2
Max SUL	46.4	78.2	56.0	46.1	74.9	61.8

**2001**

	<b>First Capture (7/15-7/16/01)</b>			<b>Second Capture (8/21-8/23/01)</b>		
	96 total			92 total		
	<b>Juvenile</b>	<b>Females</b>	<b>Males</b>	<b>Juv</b>	<b>Females</b>	<b>Males</b>
Number Caught	35	29	32	23	27	42
Percent juv/female/male	36%	30%	33%	25%	29%	46%
Mean SUL (mm)	42.0	56.6	52.2	42.3	57.1	53.0
SUL, SE	0.56	1.22	0.66	0.78	1.73	0.59
Min. SUL	31.1	46.6	46.5	33.1	46.3	45.7
Max SUL	46.0	72.4	58.6	45.7	73	62.6
Mean Wt (g)	8.6	22.0	16.5	9.8	23.8	19.0
Weight, SE	0.31	1.48	0.55	0.45	2.16	0.68
Min Wt	3.5	9.7	11.0	5.0	8.5	8.5
Max WT	11.5	45.5	22.0	13.5	44.5	31
Ratio Weight/Length, me	0.20	0.38	0.31	0.23	0.40	0.36
Ratio Weight/Length, SE	0.005	0.018	0.008	0.008	0.025	0.009

**2002**

	<b>First Capture (8/1-8/2/02)</b>			<b>Second Capture (9/4-9/5/02)</b>		
	85 total			40 total		
	<b>Juvenile</b>	<b>Females</b>	<b>Males</b>	<b>Juv</b>	<b>Females</b>	<b>Males</b>
Number Caught	5	42	38	3	21	16
Percent juv/female/male	6%	49%	45%	8%	53%	40%
Mean SUL (mm)	39.8	58.1	54.1	39.8	62.3	53.8
SUL, SE	0.78	0.71	0.51	2.80	1.45	0.79
Min. SUL	37.5	45.9	44.8	34.6	46.2	46.5
Max SUL	42.0	67.4	58.9	44.2	76.5	59.2
Mean Wt (g)	7.7	24.7	20.3	8.2	31.8	21.2
Weight, SE	0.37	0.98	0.67	1.59	2.34	0.88
Min Wt	7	12	10	5.5	14	14
Max WT	9	41.5	31	11	58	27
Ratio Weight/Length, me	0.19	0.42	0.37	0.20	0.50	0.39
Ratio Weight/Length, SE	0.007	0.012	0.010	0.026	0.026	0.012

*continued next page*

Table 6. Lodge Creek capture results, 2000-2003, continued

**2003**

	<b>First Capture (7/14 &amp; 7/16/03)</b>			<b>Second Capture (8/6 &amp; 8/8/03)</b>			<b>Third Capture (8/26-8/28/03)</b>		
	total = 79			total = 70			total = 57		
	<b>Juv</b>	<b>Females</b>	<b>Males</b>	<b>Juv</b>	<b>Females</b>	<b>Males</b>	<b>Juv</b>	<b>Females</b>	<b>Males</b>
Number Caught	10	42	27	11	36	23	7	29	21
Percent juv/female/male	13%	53%	34%	16%	51%	33%	12%	51%	37%
Mean SUL (mm)	31.2	61.0	54.1	35.2	63.4	54.9	29.9	63.3	55.7
SUL, SE	1.65	0.85	0.52	1.56	0.93	0.89	1.62	1.09	0.61
Min. SUL	26.1	46.2	47.8	28.8	54.7	47.1	24.3	47.1	49.1
Max SUL	44.4	71.2	59.2	44.3	79.0	69.0	34.6	69.0	60.2
Mean Wt (g)	3.9	28.3	19.5	5.5	33.1	21.4	3.6	32.7	22.8
Weight, SE	0.90	1.15	0.60	0.78	1.75	1.12	0.48	1.74	0.63
Min Wt	2.0	11.5	11.5	3.5	19.0	11.0	2.0	16.5	18.0
Max WT	11.5	42.5	24.0	11.5	62.0	37.0	5.0	56.0	28.0
Ratio Wt/SUL, mean	0.12	0.46	0.36	0.15	0.51	0.39	0.12	0.51	0.41
Ratio Wt/SUL, SE	0.018	0.014	0.009	0.014	0.022	0.015	0.010	0.020	0.008



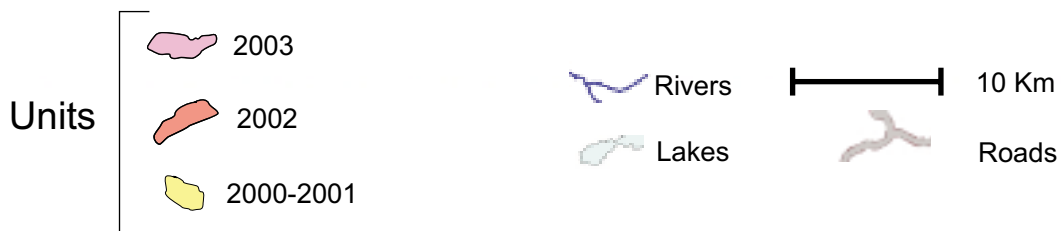


Figure 1. Yellowstone National Park, catchments surveyed for amphibians, 2000-2003.

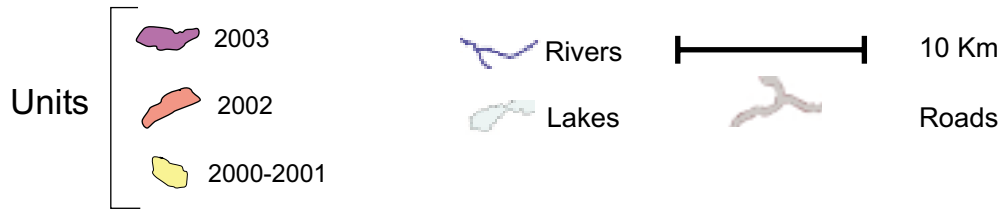
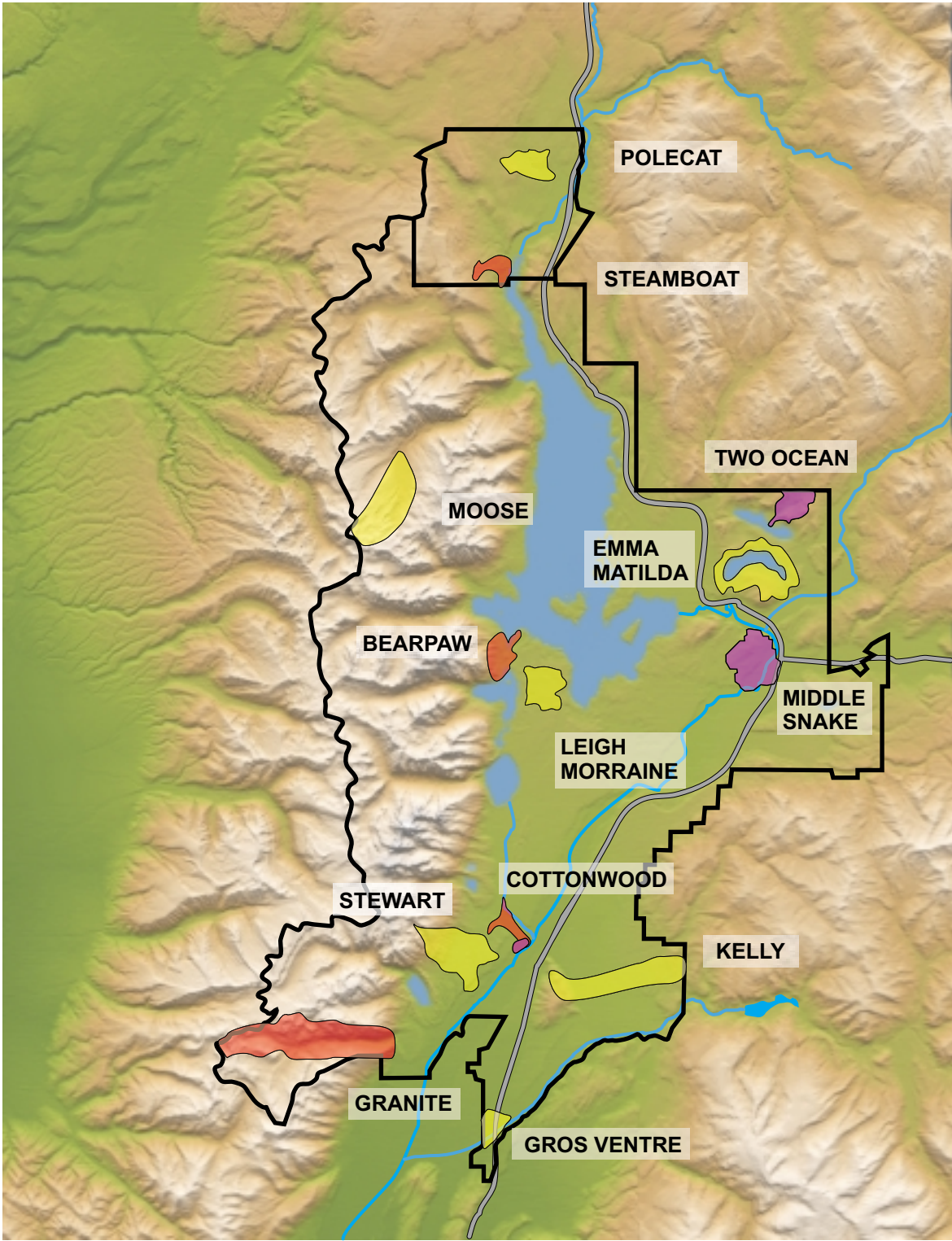


Figure 2. Grand Teton National Park and J.D. Rockefeller Memorial Parkway, catchments surveyed for amphibians, 2001-2003.

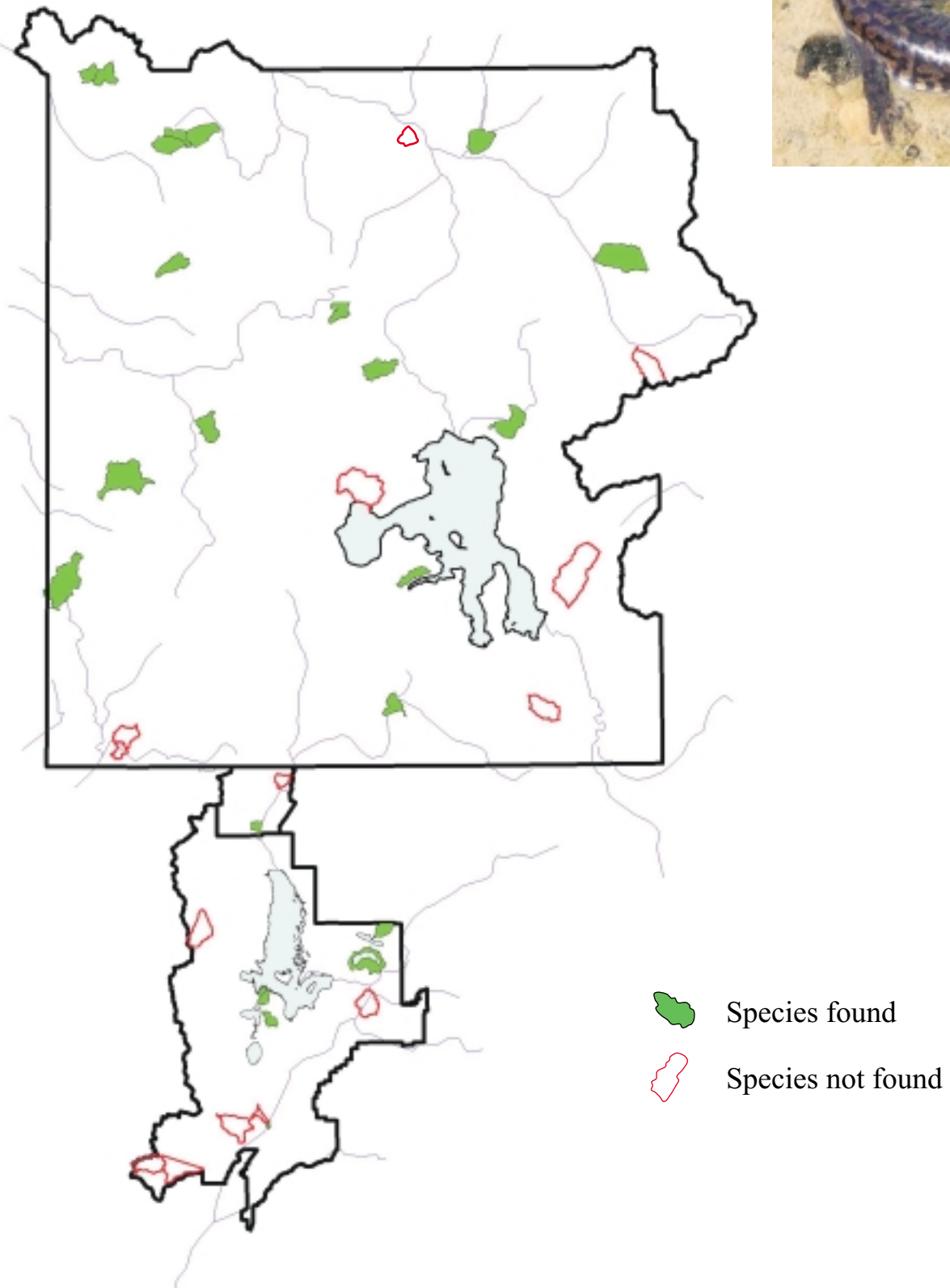


Figure 3. Blotched Tiger Salamander, catchments where the species was found (any life stage) and not found during surveys in YELL and GRTE, 2000-2003.

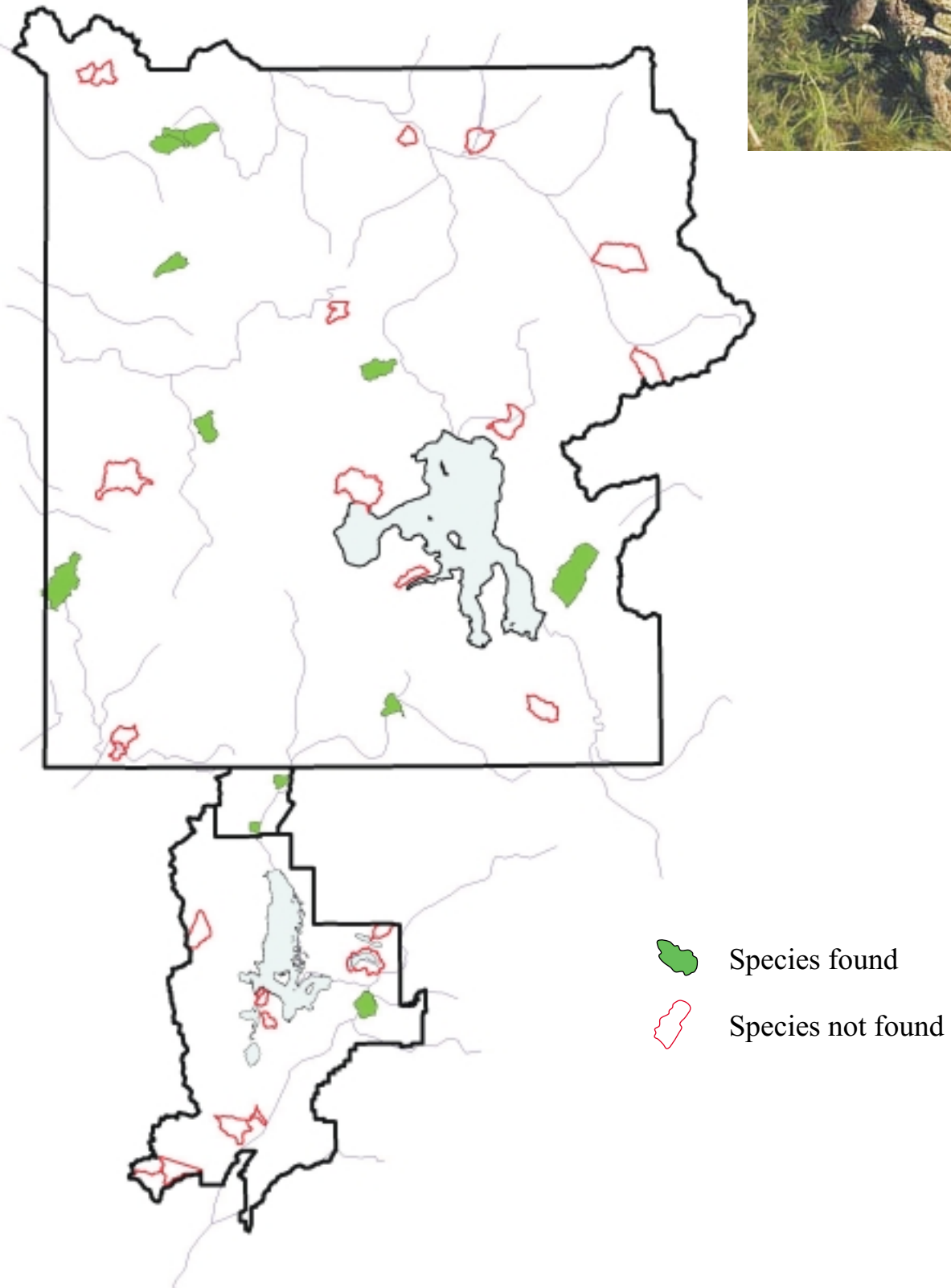


Figure 4. Boreal Toad, catchments where the species was found (any life stage) and not found during surveys in YELL and GRTE, 2000-2003.

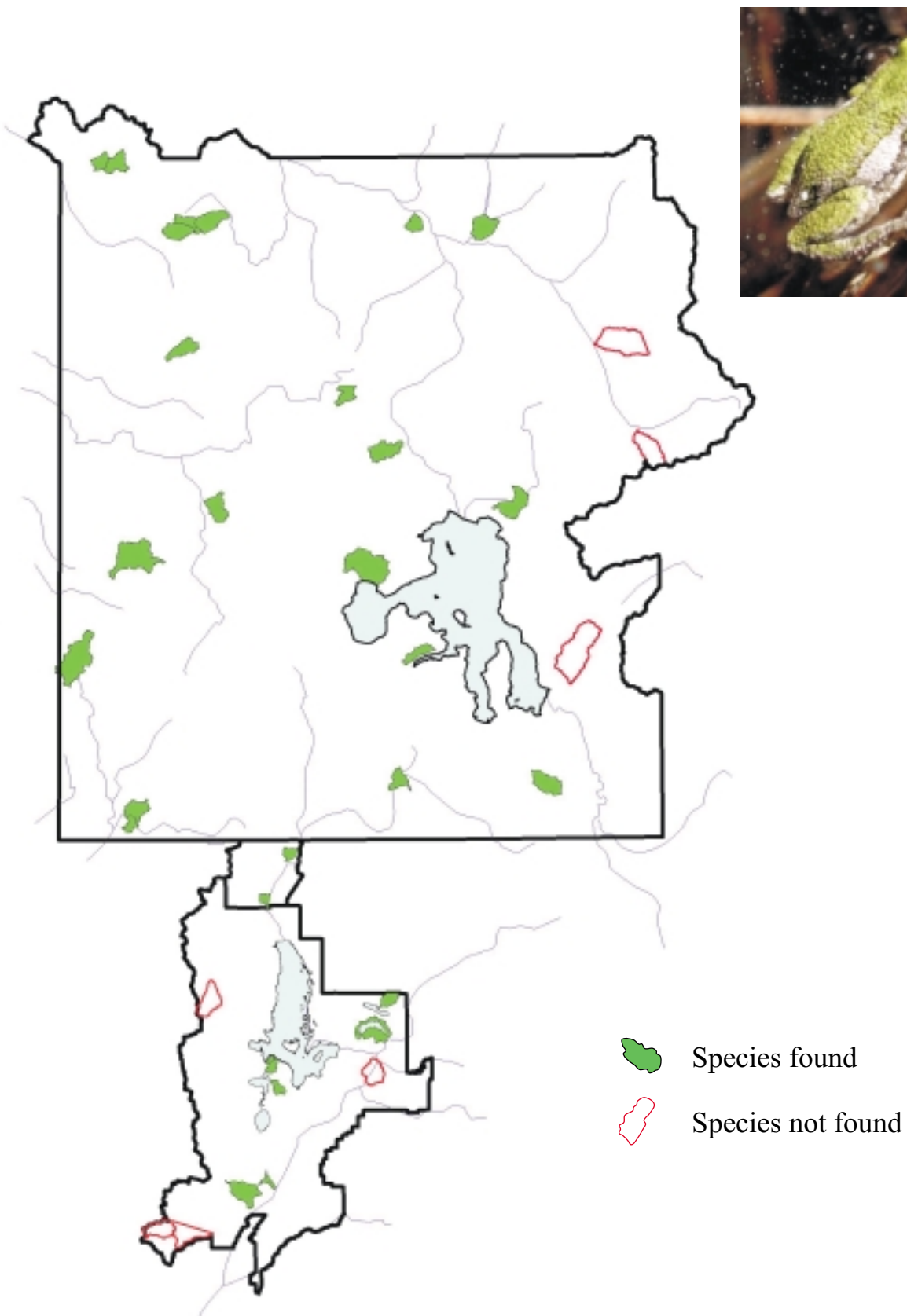


Figure 5. Boreal Chorus Frog, catchments where the species was found (any life stage) and not found during surveys in YELL and GRTE, 2000-2003.

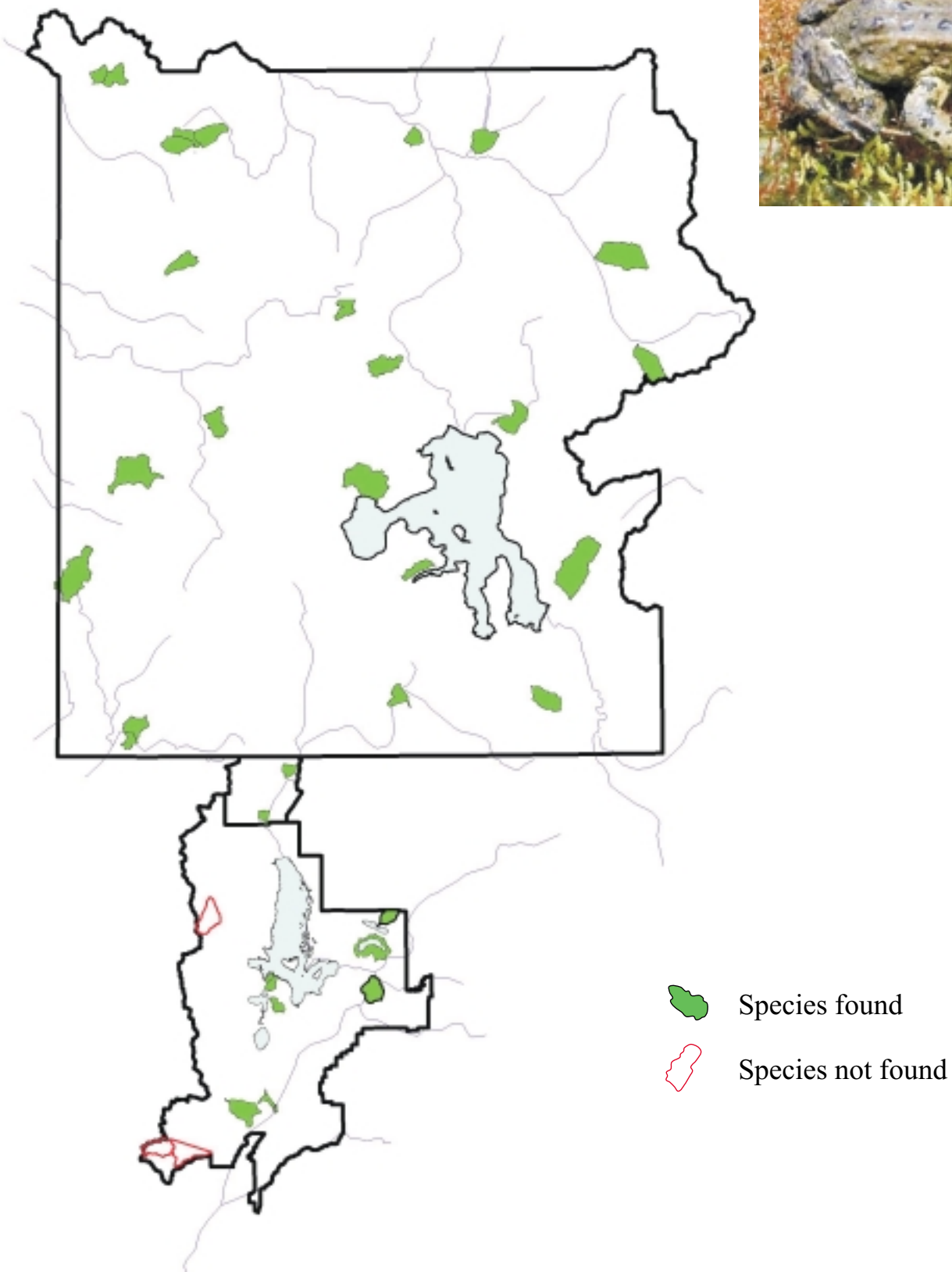


Figure 6. Columbia Spotted Frog, catchments where the species was found (any life stage) and not found during surveys in YELL and GRTE, 2000-2003.

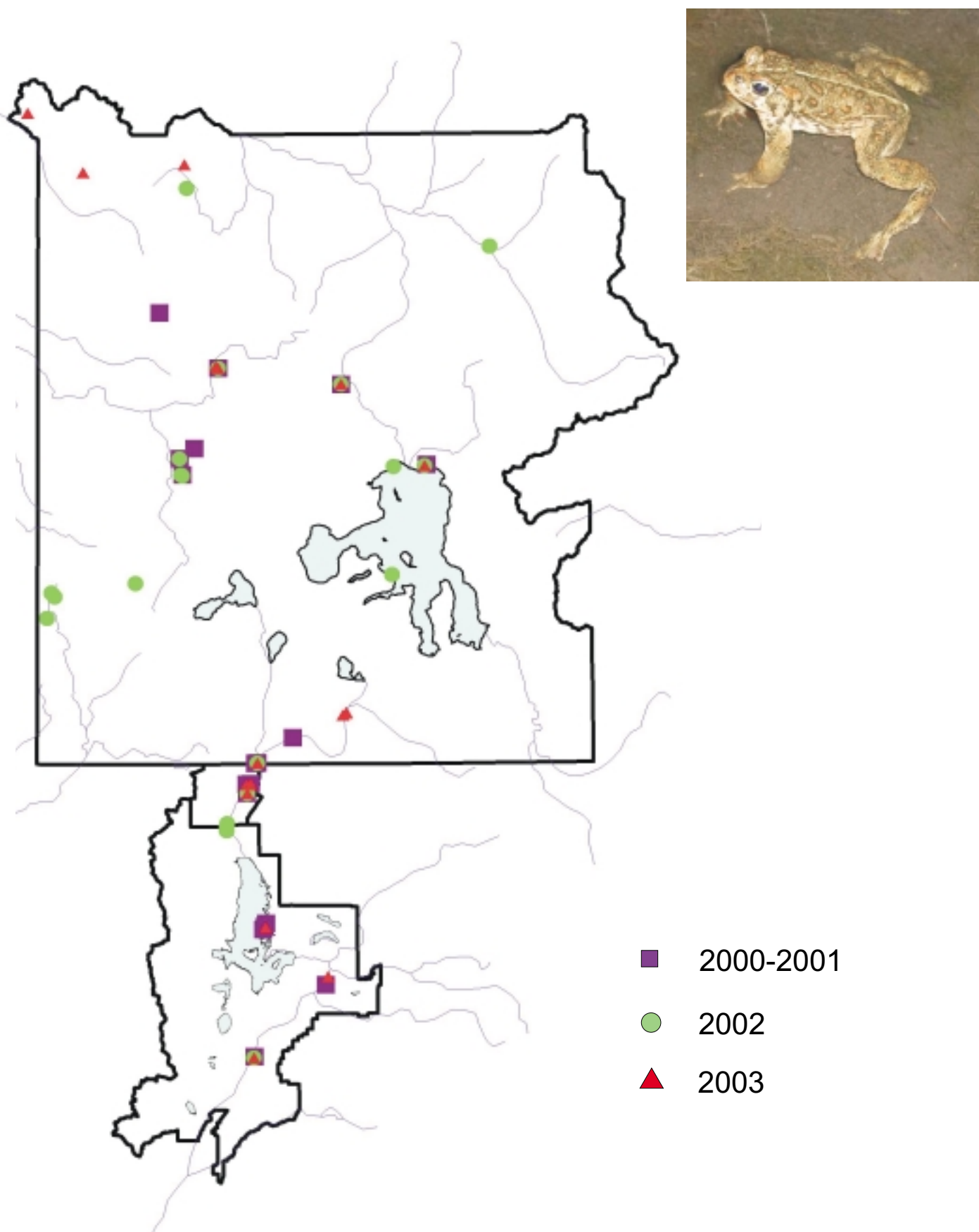


Figure 7. Boreal Toad, active breeding sites (eggs, tadpoles, or recent metamorphs found) in YELL and GRTE, 2000-2003.

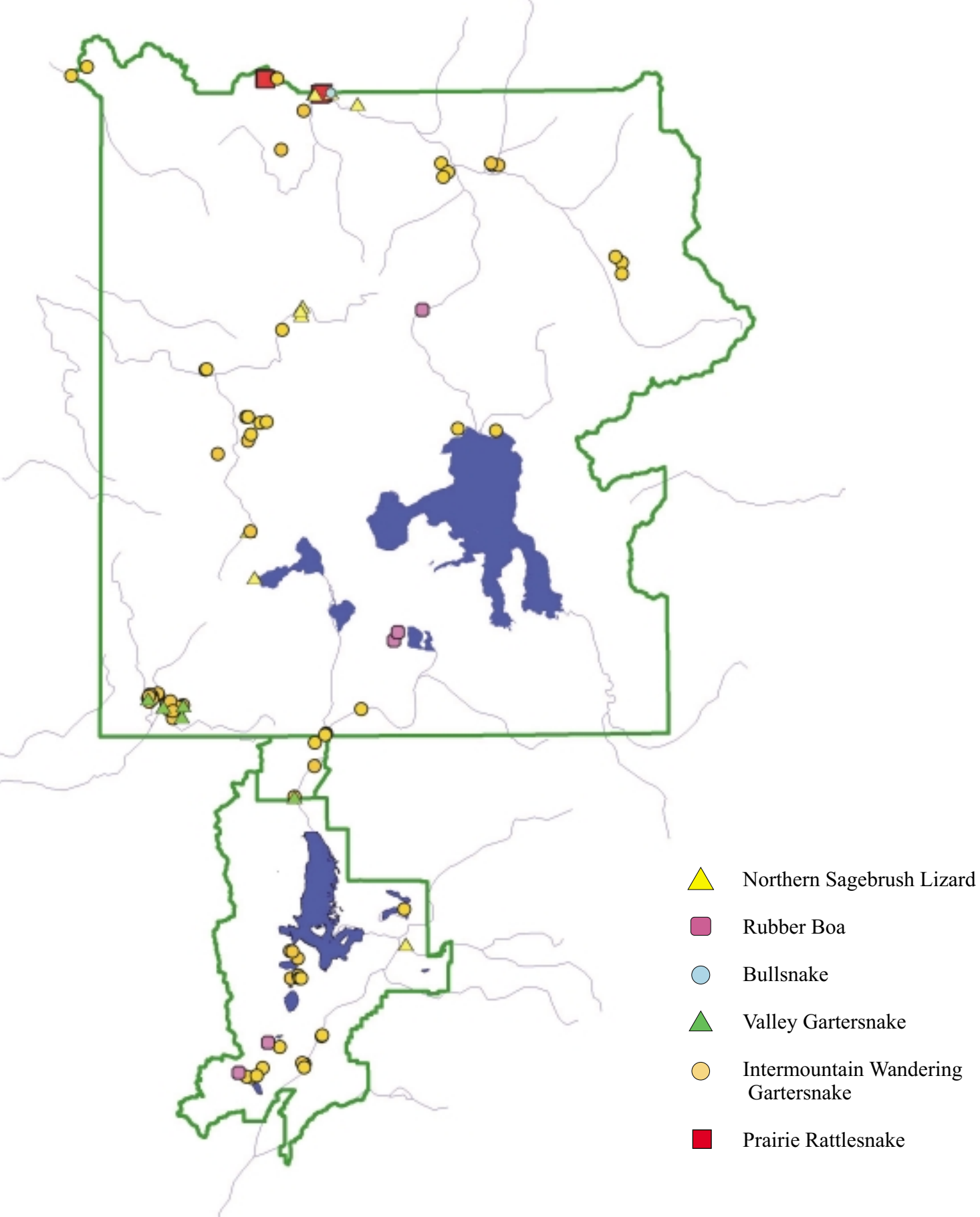


Figure 8. Locations of reptile observations, YELL and GRTE, 2000-2003.

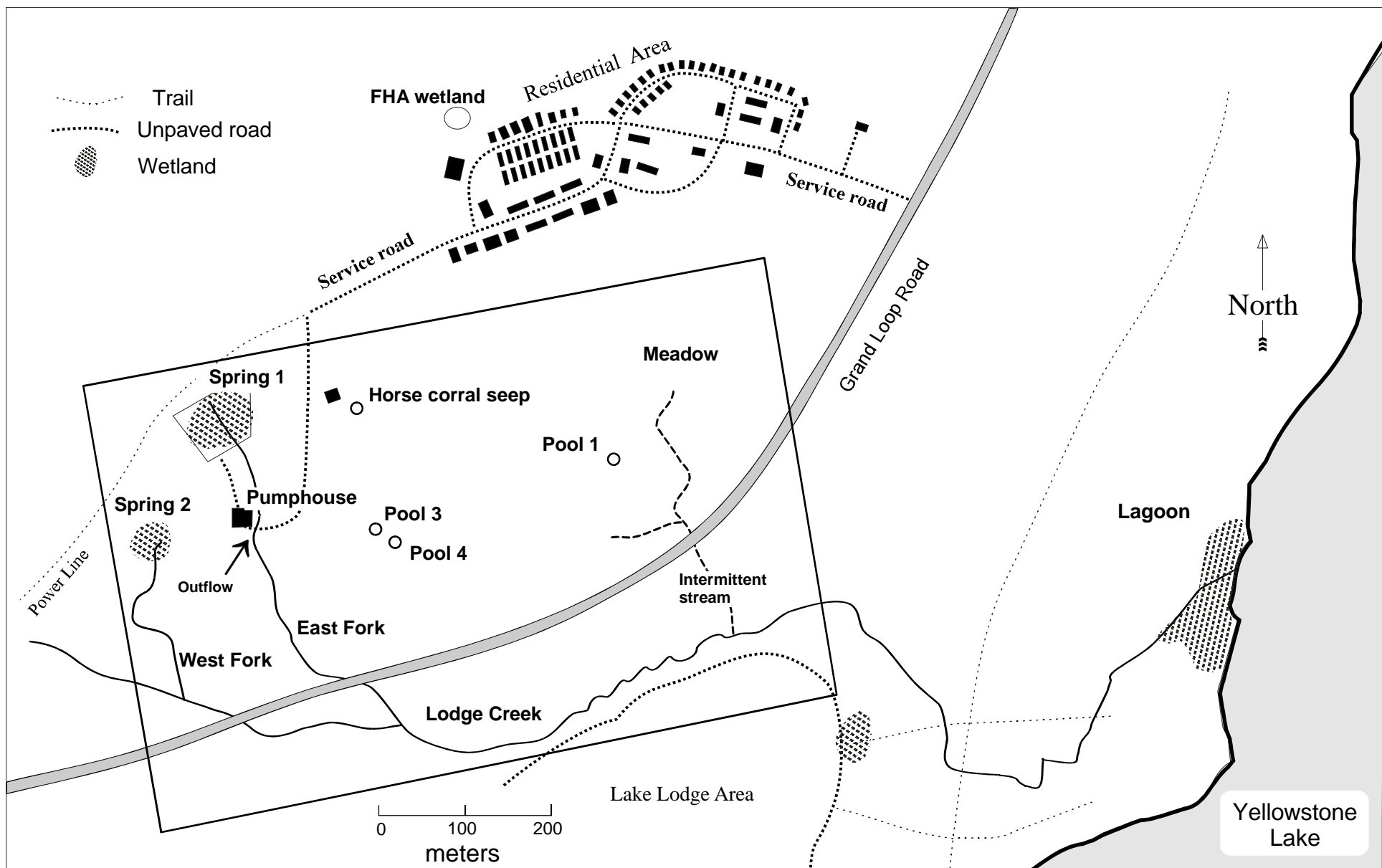


Figure 9. Lodge Creek apex site and study area. Work is focused at the labeled sites within the rectangle and at FHA wetlands northwest of the residential area. Less intensive monitoring is conducted along Lodge Creek downstream of the rectangle and at the lagoon at the mouth of Lodge Creek.

Updated List of Amphibian Species Grand Teton National Park (including J.D. Rockefeller Memorial Parkway)					Appendix I
Common Name	Scientific Name	Subspecies	Former Names (if any)	Status	Notes
Tiger Salamander	<i>Ambystoma tigrinum</i>	Blotched Tiger Salamander ( <i>Ambystoma tigrinum melanostictum</i> )		Present in Park	Detected during all years of surveys, widespread but relatively uncommon.
Western Toad	<i>Bufo boreas</i>	Boreal Toad ( <i>Bufo boreas boreas</i> )		Present in Park	Detected during all years of surveys, widespread but relatively uncommon.
Boreal Chorus Frog	<i>Pseudacris maculata</i>		Western Chorus Frog ( <i>Pseudacris triseriata</i> ); Boreal Chorus Frog ( <i>Pseudacris triseriata maculata</i> )	Present in Park	Detected during all years of surveys, widespread.
Columbia Spotted Frog	<i>Rana luteiventris</i>		Spotted Frog ( <i>Rana pretiosa</i> )	Present in Park	Detected during all years of surveys, widespread.
American Bullfrog	<i>Rana catesbeiana</i>		Bullfrog	Present in Park	Introduced species. Limited to Kelly Warm Springs area. First documented in 1950s. Potential for spreading to other warm-water habitats.
Northern Leopard Frog	<i>Rana pipiens</i>			Historic & unconfirmed	Historically present. No verified documentation since 1995 or 96, in the Flagg Ranch area. May persist as small or isolated populations in lower elevation portions of northern GRTE or JODR.

Updated List of Reptile Species Grand Teton National Park (including J.D. Rockefeller Memorial Parkway)					Appendix I
Common Name	Scientific Name	Subspecies	Former Names (if any)	Status	Notes
Common Sagebrush Lizard	<i>Sceloporus graciosus</i>			Present in Park	Found in the 1960s and 1990s near Pilgrim Cr, and at a few other locations in the 1990s.
Rubber Boa	<i>Charina bottae</i>			Present in Park	
Gophersnake	<i>Pituophis catenifer</i>	Great Basin Gophersnake ( <i>Pituophis catenifer deserticola</i> )		Unconfirmed	One roadkill reported at Gros Ventre Junction, prior to 1995.
Common Gartersnake	<i>Thamnophis sirtalis</i>	Valley Gartersnake ( <i>Thamnophis sirtalis fitchi</i> )		Present in Park	Found during surveys in JODR in 2002, & found in GRTE.
Terrestrial Gartersnake	<i>Thamnophis elegans</i>	Intermountain Wandering Gartersnake ( <i>Thamnophis elegans vagrans</i> )	Wandering Garter Snake	Present in Park	Detected during all years of surveys

Updated List of Amphibian Species Yellowstone National Park					Appendix I
Common	Scientific Name	Subspecies	Former Names (if any)	Status	Notes
Tiger Salamander	<i>Ambystoma tigrinum</i>	Blotched Tiger Salamander ( <i>Ambystoma tigrinum melanostictum</i> )		Present in Park	Detected during all years of surveys, widespread.
Western Toad	<i>Bufo boreas</i>	Boreal Toad ( <i>Bufo boreas boreas</i> )		Present in Park	Detected during all years of surveys, widespread but relatively uncommon.
Boreal Chorus Frog	<i>Pseudacris maculata</i>		Western Chorus Frog ( <i>Pseudacris triseriata</i> ); Boreal Chorus Frog ( <i>Pseudacris triseriata maculata</i> )	Present in Park	Detected during all years of surveys, widespread.
Columbia Spotted Frog	<i>Rana luteiventris</i>		Spotted Frog ( <i>Rana pretiosa</i> )	Present in Park	Detected during all years of surveys, widespread.
Northern Leopard Frog	<i>Rana pipiens</i>			Unconfirmed	Unconfirmed report Bechler Meadows1992. Inhabits Henry’s Fork Snake River downstream of YELL and may occur in lower elevation portions of SW YELL.
Great Basin Spadefoot or Plains Spadefoot	<i>Spea intermontana</i> or <i>S. bombifrons</i>		Scaphiopus spp.	Unconfirmed	Uncofirmed report (1982).

Updated List of Reptile Species Yellowstone National Park					Appendix I
Common Name	Scientific Name	Subspecies	Former Names (if any)	Status	Notes
Common Sagebrush Lizard	<i>Sceloporus graciosus</i>	Northern Sagebrush Lizard ( <i>Sceloporus graciosus graciosus</i> )		Present in Park	Isolated populations in thermal areas
Greater Short-horned Lizard	<i>Phrynosoma hernandesi</i>		(Eastern) Short-horned Lizard ( <i>Phrynosoma douglassii brevirostre</i> )	Historic	Historical record in Firehole River basin, & reported sighting at West Entrance in 1954.
Rubber Boa	<i>Charina bottae</i>			Present in Park	
Eastern Racer	<i>Coluber constrictor</i>	Eastern Yellow-bellied Racer ( <i>Coluber constrictor flaviventris</i> )		Encroaching & unconfirmed	One observation along lower Yellowstone River in 1984.
Gophersnake	<i>Pituophis catenifer</i>	Bullsnake ( <i>Pituophis catenifer sayi</i> )		Present in Park	Northwest YELL, lower elevations
Common Gartersnake	<i>Thamnophis sirtalis</i>	Valley Gartersnake ( <i>Thamnophis sirtalis fitchi</i> )		Present in Park	Found during amphibian surveys in SW YELL in 2002.
Terrestrial Gartersnake	<i>Thamnophis elegans</i>	Intermountain Wandering Gartersnake ( <i>Thamnophis elegans</i> )	Wandering Garter Snake	Present in Park	Detected during all years of surveys.
Western Rattlesnake	<i>Crotalus viridis</i>	Prairie Rattlesnake ( <i>Crotalus viridis viridis</i> )		Present in Park	Northwest YELL, lower elevations

# Survey Data Sheet for GYE Amphibians 2003

<b>Date</b>		<b>Observer(s):</b>				<b>Watershed name &amp; code:</b>				
		<b>Recorder:</b>								
<b>Site Name</b>			<b>Pre-Assigned Code:</b>		<b>Locality</b>					
<b>UTM East</b>			<b>UTM North</b>		<b>UTM EPE</b>		<b>Zone</b>	<b>Datum</b>	<b>Visit Number this year</b>	
<b>Begin Time</b>		<b>End Time</b>		<b>Total minutes of Survey:</b>			<b>Site detection (circle):</b> NW I unit    Topo Map    Photo    Incidental			
				<b>Number of persons searching:</b>						
<b>State</b>		<b>County</b>		<b>Land Owner</b>			<b>Elevation (from topo)</b>		<b>Topo name</b>	
<b>Weather:</b>		Clear    Overcast    Partly cloudy    Fog or mist    Rain					<b>Wind:</b>		Calm    Light    Mod    Strong	
<b>Air Temp</b>		<b>Water Temp</b>		<b>Water pH</b>		<b>Color:</b> Clear    Stained		<b>Turbidity:</b> Clear    Cloudy		
				<b>Cond</b>						
<b>Site Description:</b>		Lake/Pond    Wet Meadow    Bog/Fen    Spring/Seep    Stream/River    Oxbow/Backwater Ditch/puddle    Site dry    Thermal site    Terrestrial    Beaver Pond:    Active or Inactive								
<b>Water Connectedness:</b>		Permanent    Temporary    Isolated					<b>Human Impacts:</b> Road    Impoundment Camp/picnic site    Maintenance area			
<b>Water Permanence:</b>		Permanent    Semi-permanent    Temporary					<b>Max Depth:</b> <1m    1-2 m    >2 m			
<b>Percent of site at &lt;50 cm depth:</b> 0    1-25    25-50    50-75    75-100						<b>Extent Water Cover:</b> 0%    1-5    6-25    26-50    51-75 76-100%				
<b>Site Length:</b> _____ <b>Site Width:</b> _____				<b>Percent of site perimeter searched:</b> 0    1-25    26-50    51-75    76-99    100						
<b>Primary Substrate:</b> Silt/Mud    Sand    Gravel    Cobble    Boulder/Bedrock    Other_____										
<b>% of Water Body with Emergent Veg:</b> 0    1-25    26-50    51-75    76-99    100						<b>North Shoreline</b> Shallows: Present    Absent <b>Characteristics:</b> Emergent Veg: Present    Absent				
<b>Rank emergent veg in order of abundance:</b> _____Sedges    _____Fine rushes    _____Grasses    _____Bulrush    _____Cattail _____Shrubs    _____Pond lily    _____Other (Describe):										
<b>Submerged aquatic veg %:</b> 1-10    11-50    51-75    76-100				<b>Distance (M) to Forest Edge:</b> _____			<b>Wetland type:</b>			
<b>Other Wildlife:</b>										
<b>Fish Present:</b> Yes    No <b>Fish species if known:</b>										

## Herpetofauna Species Information (include reptiles)

Species * for breeding	Life History Stage	Number of Individuals (sex if known)	Range of Sizes	Detection Method*	Photo No.	Comments (UTM for larvae or eggs, number of dead) List Wetland type for eggs and larvae

**\*Detection Method abbreviations:** Visual only =VID    Caught and handled =HC    Auditory =A

## Site Map

Grid Scale: \_\_\_\_\_

Site Number: \_\_\_\_\_


*Indicate where in drawing GPS point was taken and where amphibian observations occurred.*

Site Photos (List: Subject, location, direction; e.g. "Main pond, south shore, looking NW")

**Remarks:**

CWD:	None	1 to 10	11 to 20	21 or more
<b>&lt;12 cm</b>	_____	_____	_____	_____
<b>12-25 cm</b>	_____	_____	_____	_____
<b>&gt;25 cm</b>	_____	_____	_____	_____

**Wetland Type**

**Site Map**

Point Name: \_\_\_\_\_ Pre-assigned code: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ Grid Scale: \_\_\_\_\_

Observers: \_\_\_\_\_

														N?

***Indicate where in drawing GPS point was taken, photo position and direction, and where amphibian observations occurred.***

Site Photos (Photo #, Location of photographer, direction camera pointing): e.g. "#2232, S shore, to NW")

**Remarks:**

Point Name: \_\_\_\_\_ Pre-assigned code: \_\_\_\_\_ Date: \_\_\_\_\_ Time: \_\_\_\_\_ Grid Scale: \_\_\_\_\_

Observers: \_\_\_\_\_

														N?

***Indicate where in drawing GPS point was taken, photo position and direction, and where amphibian observations occurred.***

Site Photos (Photo #, Location of photographer, direction camera pointing): e.g. "#2232, S shore, to NW")

**Remarks:**

## **Appendix III**

### **Notes on the 2003 database**

The 2003 relational database contains the results of the systematic amphibian surveys, monitoring at several sites in YELL and GRTE (e.g., visits to previously-identified toad breeding sites and the Lodge Creek spotted frog study area), and incidental observations of reptiles. It has four linked tables: Locations, Survey, Animal Observations, and Capture. Explanatory notes about fields are provided in the Description field that is accessed in design view of the tables. Data fields are similar to the 2002 database, following the database design provided to us by USGS-ARMI in 2002. I did not combine 2003 data with 2002 data because a thorough revision of the database is pending. With I&M, we hope to combine the 2002 and 2003 data with the 2000-2001 data, which predates the ARMI database and is housed separately. The most significant difference is that in the 2002 and 2003 databases each life stage of each species at each site surveyed is recorded with a separate record, whereas one record serves to describe all life stages per species per site survey in the 2000-2001 database. The databases have been subjected to quality control (e.g., correction of gross errors in UTM coordinates due to transposed numbers), but they still contain some errors and inconsistencies that need to be resolved when the databases are combined.

## Specimen List, 2002 and 2003, GRTE and YELL

Submitted to National Wildlife Health Center, by D. Patla on 10/14/03

**Id Number:** GYE-2002-1

**Species and Number submitted:** *Rana luteiventris*, 1    **Life stage:** Adult    **Age/sex:** Female

**Condition of collected animal:** Found on the bottom of the small spring that drains into Slide Lake on west side. Eggs extruding; looks dead a while.

**Date collected:** 5/20/02

**Collected by:** D. Patla

**Method of collection:** 75% ethanol

**Location:** Slide Lake, Yellowstone National Park

**County:** Park    **State:** MT

**Latitude/longitude:** N45E 0' 14" W110E 41' 57"

**Elevation:** 1750 m

**Environmental factors:** Pond level low due to drought

**Clinical signs:** Unusual to see a dead frog on bottom rather than floating.

**Area description:** Permanent pond in a basin, fed by spring-creek

**Other amphibians or fish:** *R. luteiventris* egg masses and tadpoles. Many dead shrimp in shallow water along the nw corner of pond.

**Comments:** This site occasionally monitored. Impression is that frog numbers and possibly tiger salamanders have declined.

**Id Number:** GYE-2002-2

**Species and Number submitted:** *Ambystoma tigrinum*, 1    **Life stage:** Adult    **Age/sex:** Male

**Condition of collected animal:** Found dead at surface of pond in bulrushes

**Date collected:** 6/11/02

**Collected by:** M. Chatfield

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Slough Cr area, site 271-2

**County:** Park    **State:** WY

**Latitude/longitude:** N45E 55' 50" W110E 18' 60"

**Elevation:** 1896 m

**Environmental factors:** Pond is low due to drought

**Area description:** Isolated, semi-permanent pond

**Other amphibians or fish:**

**Id Number:** GYE-2002-3

**Species and Number submitted:** *Rana luteiventris*, 1    **Life stage:** adult form    **Age/sex:** Juvenile

**Condition of collected animal:** not reported

**Date collected:** 6/12/02

**Collected by:** Matt Chatfield

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Hayden Valley, Site 245-9

**County:** Park

**State:** WY

**Latitude/longitude:** N44E 38' 48" W110E 31' 11"

**Elevation:** 2365 m

**Environmental factors:** May be set of 2 or 3 smaller sites later in summer

**Clinical signs:** not reported

**Area description:** Permanent pond

**Other amphibians or fish:** Tadpoles of *R. luteiventris* tadpoles and adults; *Pseudacris maculata* eggs and adults, one *Bufo boreas* juvenile found.

**Id Number:** GYE-2002-4

**Species and Number submitted:** *Pseudacris maculata*, 1    **Life stage:** tadpole

**Condition of collected animal:** not reported

**Date collected:** 7/3/02

**Collected by:** G. Carnwath

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Hayden Valley, Site 245-9

**County:** Park

**State:** WY

**Latitude/longitude:** N44E 38' 48" W110E 31' 11"

**Elevation:** 2365 m

**Environmental factors:** May be set of 2 or 3 smaller sites later in summer

**Clinical signs:** not reported

**Area description:** Permanent pond

**Other amphibians or fish:** *R. luteiventris* tadpoles and juveniles; *Pseudacris maculata* tadpoles.

**Comments:** This is the same site as GYE-2002-3, above.

**Id Number:** GYE-2002-5

**Species and Number submitted:** *Pseudacris maculata* and *Rana luteiventris*, several of each

**Life stage:** tadpole

**Condition of collected animal:** floating in pond

**Date collected:** 6/30/02

**Collected by:** G. Carnwath

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Hayden Valley, Site 245-52 **County:** Park **State:** WY

**Latitude/longitude:** N44E 38' 28" W110E 29' 20" **Elevation:** 2370 m

**Environmental factors:** Very windy

**Mortality:** About 30 dead *P. maculata* and 15 dead *R. luteiventris* tadpoles found

**Area description:** Isolated, semi-permanent pond, 30 x 100 m

**Other amphibians or fish:** *R. luteiventris* tadpoles and juveniles; *Pseudacris maculata* tadpoles, *Ambystoma tigrinum* larvae

**Id Number:** GYE-2002-6

**Species and Number submitted:** *Pseudacris maculata*, 5

**Life stage:** tadpole (Pre-metamorphs, well developed hind legs)

**Condition of collected animal:** floating in pond

**Date collected:** 7/2/02

**Collected by:** G. Carnwath

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Hayden Valley, Site 245-70 **County:** Park **State:** WY

**Latitude/longitude:** N44E 38' 39" W110E 31' 5" **Elevation:** 2377 m

**Mortality:** About 10 dead *P. maculata* pre-metamorphs (well developed hind legs) seen

**Area description:** Temporary pond, 30 x 40 m

**Other amphibians or fish:** *R. luteiventris* and bufo boreas adults; *Pseudacris maculata* tadpoles (100+)

**Id Number:** GYE-2002-7

**Species and Number submitted:** *Pseudacris maculata*, 1 **Life stage:** Tadpole

**Condition of collected animal:**

**Date collected:** 7/10/02

**Collected by:** M. Chatfield

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Fall River area, Site 1436-1 **County:** Teton **State:** WY

**Latitude/longitude:** N44E 9' 33" W110E 57' 20" **Elevation:** 1963

**Environmental factors:** Water temperature 26EC (warm)

**Mortality:** Only 1 dead tadpole found

**Area description:** Pools in wet meadow, 230 x 100 m

**Other amphibians or fish:** *Pseudacris maculata* juveniles and metamorphosing tadpoles

**Id Number:** GYE-2002-8

**Species and Number submitted:** *Rana luteiventris*, 2 **Life stage:** Tadpole

**Date collected:** 7/10/02

**Collected by:** M. Chatfield

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Fall River area, Site 1436-3 **County:** Teton **State:** WY

**Latitude/longitude:** N44E 10' 4" W110E 57' 20" **Elevation:** 1963

**Environmental factors:** Water temperature 26EC (warm)

**Mortality:** 2 dead tadpoles found

**Area description:** Semipermanent pond, 100 x 20 m

**Other amphibians or fish:** *Pseudacris maculata* juveniles and metamorphosing tadpoles; *Rana luteiventris* tadpoles and adults

**Id Number:** GYE-2002-9

**Species and Number submitted:** *Rana luteiventris*, **Life stage:** Tadpole

**Date collected:** 7/16/02

**Collected by:** M. Chatfield

**Method of collection:** 75% ethanol

**Location:** Yellowstone National Park, Fall River area, Site Bech-8 **County:** Teton **State:** WY

**Latitude/longitude:** N44E 11' 27" W110E 59' 4" **Elevation:** 1945

**Mortality:** 5 dead indiv, 1 dying and 1 died after captured. 2 indiv collected, others badly decomposed.

**Area description:** Marshy area next to slow stream, 50 x 35 m

**Other amphibians or fish:** *Pseudacris maculata* and *Rana luteiventris* tadpoles and metamorphosing tadpoles

**Id Number:** GYE-2002-10

**Species and Number submitted:** *Bufo boreas*, 4 **Life stage:** Metamorph

**Condition of collected animal:** Many carcasses in the water and on shore; mostly quite decomposed or desiccated.

**Date collected:** 8/8/02

**Collected by:** D. Patla

**Method of collection:** 75% ethanol

**Location:** JD Rockefeller Memorial Parkway, Grand Teton National Park, Snake River pit

**County:** Teton

**State:** WY

**Latitude/longitude:** N44E 5' 26" W110E 40' 57" **Elevation:** 2073

**Environmental factors:** Falling water levels, windy and cold the last few days

**Clinical signs:** Many metamorphs appear to have recently emerged from the water; appear to have died of exposure if disease is not the cause.

**Mortality:** 10 dead tadpoles, 100+ dead metamorphs. The dead were concentrated at NE corner of the pond.

**Area description:** Quarry ponds excavated in Snake R flood plain

**Other amphibians or fish:** About 35 live *Bufo boreas* metamorphs and <20 tadpoles in and around pond.

**Comments:** Wetland restoration crew said they saw many dead toadlets here 2 days ago

**Id Number:** GYE-2003-2

**Species and Number submitted:** *Bufo boreas* **Life stage:** Adult

**Condition of collected animal:** In shallow water, decomposed, near breeding site

**Date collected:** 5/16/03

**Collected by:** D. Patla

**Method of collection:** 70% ethanol

**Location:** Grand Teton NP, Schwabacker Landing **County:** Teton **State:** WY

**Latitude/longitude:** N43E 42' 51" W110E 40' 16" **Elevation:** 2000 m

**Environmental factors:** pH 9.1

**Mortality:** One other dead female found on other side of stream

**Area description:** Beaver-dammed tributary stream of Snake River

**Other amphibians or fish:** *B. boreas* egg strings, juveniles, and adults; *R. luteiventris* juveniles and adults

**Id Number:** GYE-2003-3

**Species and Number submitted:** *Bufo boreas* **Life stage:** Adult **Age/sex:** Female

**Condition of collected animal:** Apparently gravid, recently dead, in water. <2 m from an egg string

**Date collected:** 5/16/03

**Collected by:** D. Patla

**Method of collection:** 70% ethanol

**Location:** Grand Teton NP, Schwabacker Landing **County:** Teton **State:** WY

**Latitude/longitude:** N43E 42' 49" W110E 40' 20" **Elevation:** 2000 m

**Environmental factors:** pH 8.9

**Clinical signs:** No apparent cause of death, not emaciated

**Mortality:** One other dead toad found on other side of stream

**Area description:** Beaver-dammed tributary stream of Snake River, recently flooded area

**Other amphibians or fish:** *B. boreas* egg strings, juveniles, and adults; *R. luteiventris* juveniles and adults

**Id Number:** GYE-2003-4

**Species and Number submitted:** *Rana luteiventris*      **Life stage:** Adult

**Condition of collected animal:** Very decomposed, guts coming out.

**Date collected:** 5/27/03

**Collected by:** D. Patla

**Method of collection:** 70% ethanol

**Location:** Yellowstone National Park, Lodge Cr      **County:** Teton      **State:** WY

**Latitude/longitude:** N44E 33' 22" W110E 23' 23"      **Elevation:** 2365 m

**Environmental factors:** near area of previous sewage spills

**Clinical signs:** too decomposed to tell

**Mortality:** No other dead amphibians found, but this is the same site where frog metamorphs were found with metacercaria parasites in August-Sept (submitted to NWHC)

**Area description:** marshy side area of creek just upstream of the lagoon

**Other amphibians or fish:** Cutthroat trout spawning stream. *R. luteiventris* adults, juveniles, eggs. *Pseudacris maculata* calling.

**Id Number:** GYE-2003-5

**Species and Number submitted:** *Bufo boreas*, 1

**Life stage:** Adult

**Date collected:** unknown

**Collected by:** D. Patla

**Method of collection:** 70% ethanol

**Location:** Unknown, lost label.

## **Frozen Specimens**

**Id Number:** GYE-2003-10

**Species and Number submitted:** *Bufo boreas*      **Life stage:** Adult

**Condition of collected animal:** Found dead, near visitor center, on land

**Date collected:** late August 2003

**Collected by:** Andrew Langford, NPS

**Method of collection:** frozen

**Location:** Grand Teton National Park, Moose Visitor Center      **County:** Teton      **State:** WY

**Latitude/longitude:** N43E 39' 50" W110E 42' 54"      **Elevation:** 1970 m

**Mortality:** Collector had been seeing a live toad in this area at night this summer

**Area description:** Developed area about 150 m west of Snake River

**Other amphibians or fish:**

**Id Number:** GYE-2003-12

**Species and Number submitted:** *Rana luteiventris*, 1      **Life stage:** Adult

**Condition of collected animal:** Found dead on bank of creek, fairly fresh

**Date collected:** 8/28/03

**Collected by:** D. Patla

**Method of collection:** frozen

**Location:** Yellowstone National Park, Sewer Creek      **County:** Park      **State:** WY

**Latitude/longitude:** N44E 35' 56" W110E 22' 23"      **Elevation:** 2335 m

**Environmental factors:** *This is the site of a large mortality event in 2002, specimens were sent to NWHC.*

**Clinical signs:** none obvious

**Mortality:** This was the only dead frog found in this survey.

**Area description:** Spring-fed stream that becomes sluggish before it reaches Yellowstone R. Frog was found about 200 m upstream of confluence with river.

**Other amphibians or fish:** About 12 *R. luteiventris* seen upstream in portion of stream that has higher gradient, all looked healthy and lively.



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## GREATER YELLOWSTONE ECOSYSTEM (GYE) SUB-REGION ROCKY MOUNTAIN ARMI REGION

### Amphibian Health Surveillance & Mortality Events

#### PROGRESS REPORT

This report is a brief, preliminary and partial report of the infectious diseases in amphibians from federal lands in northwestern Wyoming. Amphibians in this preliminary report were collected in Yellowstone National Park, Grand Teton National Park, National Elk Refuge and Bridger-Teton National Forest. The attached table lists amphibians alphabetically by site of capture, and then alphabetically by species within each site. Excluded from this preliminary report are a few amphibians from mortality events in two counties in Montana (Park and Gallatin) bordering on Yellowstone National Park. A formal final report for amphibians from ARMI monitoring sites and mortality events near Yellowstone NP will be completed in coming weeks.

**Sites and Species.** Four species of endemic amphibians and one invasive species (*Rana catesbeiana*) have been examined from 18 to 20 sites mostly within two national parks, a refuge and a national forest. The number of sites in Yellowstone NP is unclear because amphibians were submitted by more than one person and different names may have been used for the same site (see attached table). For example, it is unclear whether "Chipmunk Creek", "Stream 1082", "Fishing Bridge" and "Creek off Yellowstone River" are separate sites or different names for one site. Submitted endemic species were *Ambystoma tigrinum*, *Bufo boreas*, *Pseudacris maculatum*, and *Rana luteiventris*. The specimens consisted of live, dead-on-arrival, chilled, frozen and fixed animals.

**Synopsis of Diseases.** Two major infectious diseases have been detected in amphibians from Yellowstone NP, National Elk Refuge and Bridger-Teton NF. Only 3 amphibians were submitted from Grand Teton National Park, and autolysis (decomposition) of all 3 animals greatly hindered diagnostic examinations and probably prevented detection of infectious diseases, if any were present. The major diseases in amphibians from GYE were ranavirus infection and chytrid fungal infection. Ranaviral infections were confirmed by three isolations of the virus in cultures from *R. luteiventris* at "Fishing Bridge" and "Stream 1082". Chytridiomycosis was detected in *B. boreas* and *R. luteiventris* from 6 sites in Yellowstone NP, NER and Bridger-Teton NF. Combined chytridiomycosis and ranaviral infection occurred in many adult *R. luteiventris* from 4 sites: "Creek off Yellowstone River", "Chipmunk Creek", "Fishing Bridge" and "Stream 1082".

**Ranavirus Infections.** Histological examinations of the five frogs from which the 3 viruses were isolated confirmed that typical abnormalities of ranaviral infection were present in the livers, spleens and kidneys. In addition, the same histological abnormalities were detected in *R. luteiventris*, *P. maculata* and *A. tigrinum* from the following sites: Grebe Lake, Lodge Creek (Headwaters Spring), Pelican Valley and Rainy Lake. One of the 3 isolated ranaviruses was analyzed by restriction endonuclease electrophoresis ("DNA fingerprinting") and the isolant was considered indistinguishable from Frog virus-3 (FV-3). FV-3 is the type-species of

*Ranavirus*, but normally is associated with bullfrogs east of the Mississippi River. Although there are insufficient data to make conclusions about the origin of ranaviruses from *R. luteiventris* throughout its range, there is a possibility the isolant from Yellowstone NP is an introduced virus; it is suspected that adult bullfrogs and green frogs (*R. catesbeiana* and *R. clamitans*) are carriers of FV-3. Based on restriction endonuclease analyses, the ranaviruses of tiger salamanders from Arizona, Utah, Idaho, Wyoming and North Dakota are distinctly different strains and have never been isolated from anurans. Hence, the suspected ranaviral infections in tiger salamanders from Rainy Lake probably are a completely different strain of virus from the ranaviruses in Columbia spotted frogs. In those post-metamorphic *R. luteiventris* with combined ranaviral and chytrid infections, in nearly all cases, the ranavirus infection was considered the cause of death.

**Chytridiomycosis.** Chytrid fungal infections were detected in *B. boreas* and *R. luteiventris* from Bridger-Teton NF, National Elk Refuge and Yellowstone NP. Chytrid infections were not detected in *Ambystoma tigrinum* and *Pseudacris maculata* in GYE, but chytrid-infected chorus frogs have been found in Rocky Mountain NP, so the species is a suitable host for this fungus. The prevalences of chytrid infections in frogs and toads from some sites were considered high and worrisome. At "Blackrock", 7 of 16 (44%) toads were infected; the prevalences at other sites were as follows: 1 of 6 (17%) at Nowlin Creek, 1 of 3 (33%) at Chipmunk Creek, 8 of 10 (80%) at Creek off Yellowstone River, 1 of 3 (33%) at Fishing Bridge, and 2 of 2 (100%) at Stream 1082. It should be noted that several amphibians from these sites were decomposed carcasses in which it was not possible to detect chytrid fungus, if it was present in the carcass. Hence, the above prevalences probably are under-estimated.

**Other Diseases & Parasites.** The precise cause of illness or death in 3 sculpins from Nowlin Creek was not determined, but one fish had marked parasitism of its eyes and brain by unidentified metacercaria. Similar infections by the trematode, *Ornithodiplostomum*, are common in minnows in the central USA and Canada; this parasite may cause death in heavily infected minnows. It is possible the same or a related genus of metacercaria were the cause of the marked subcutaneous swellings of the rumps of 6 recently metamorphosed *R. luteiventris* from Lower Lodge Creek in early September, 2003. The metacercaria from the frogs were identified by a parasitologist as belonging to the family, Diplostomidae. Because of the immaturity of the sexual organs and other organs of metacercaria, it is not possible to identify the metacercaria from the frogs to genus or species. Pathology reports generally avoid making long lists of diseases that were not found in an animal or population, but it is noteworthy that several important infectious diseases have not been detected in amphibians from GYE; these include the new tadpole disease, *Anuraperkinsus*, the primitive fungus, *Ichthyophonus*, and the malformation-inducing parasite, *Ribeiroia*.

**Recommendations.** Please review the named sites in the attached table to determine if any sites have duplicate names or are improperly grouped or missing.

In 2004, it is requested that any additional sick amphibians and specimens from mortality events be submitted for diagnostic examinations. Of special concern is the presence of any introduced (alien) amphibians. Monitoring of amphibians at those sites where ranaviruses were isolated or suspected based on histology should be continued in 2004 to determine if this infectious disease has had an impact on population size. It appears that collection of toad skins that have been left by predators or scavengers is a satisfactory specimen for limited diagnostic testing, but such skin should be placed immediately in 70% ethanol for fixation. Ethanol-fixed specimens are suitable for molecular tests (ie PCT tests), whereas, formalin-fixed specimens cannot be used in molecular tests.

Wherever any alien or introduced amphibians are found at ARMI survey sites or casualty sites, it is requested these populations be sampled for diagnostic evaluations. For example, it would be desirable to perform diagnostic examinations on more bullfrogs from Grand Teton NP, and any other sites with GYE in which they

are found.

A laboratory that performs water mold cultures has been found, so it is now possible to obtain precise genus and species identifications of water molds in amphibian eggs. Two eggmasses of *R. luteiventris* from Lodge Creek Lagoon were infected (or invaded) by the watermold, *Achlya glomerata*. Because there was a 7-8 day interval between collection of the eggs and start of watermold cultures, it is not clear whether this watermold infected live eggs or was merely invading dead eggs as part of the normal process of decomposition of aquatic organisms. If any diseased or moldy eggmasses are detected during monitoring at ARMI sites, it is recommended that they be submitted promptly so that water mold cultures may be done.

Routine sampling of salamanders at ARMI monitoring sites also should be considered in 2004.

Our Center has a strong interest and research program on West Nile virus, but this virus has not yet been documented in amphibians. The potential impact of this introduced virus on diurnal, basking amphibian species is largely unknown. Submission of sub-adult and adult basking frogs (that have the greatest chance of being bitten by mosquitoes) such as *Rana catesbeiana* from any site where they are common is requested in 2004 for West Nile virus detection.

Discussions are recommended prior to onset of the 2004 amphibian season to select old sites, new sites, species and lifestages for sampling.

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ATCH: Table of Greater Yellowstone Ecosystem amphibians & preliminary diagnoses

**Preliminary Diagnostic Findings in Amphibians from the Greater Yellowstone Ecosystem (Grouped by Park)**  
**Received from D. Earl Green, DVM, USGS National Wildlife Health Center, Madison, WI**  
**([david\\_green@usgs.gov](mailto:david_green@usgs.gov); tele 608-270-2482)**

NWHC							
<b>Case&amp; Access.</b>	<b>Species</b>	<b>Life Stage</b>	<b>Site</b>	<b>Capt Date</b>	<b>Mass (gm)</b>	<b>Primary Diagnosis</b>	<b>Secondary Diagnosis</b>
4779-007	B. boreas	Larva	GTNP/Polecat Creek	17-Jul-01	0.59	Autolysis	
4779-030	R. luteiventris	Adult	GTNP/Polecat Cr	17-Jul-01	11.950	Bite wounds	Autolysis
4779-024	R. catesbeiana	Larva	GTNP/Kelly WS	23-Jul-01	12.000	Malformed tooththrows	Autolysis
4779-029	R. luteiventris	RM	YNP/Indian Pond	28-May-01	1.20	Fractured R femur	
4779-031	R. luteiventris	Adult	YNP/Arnica Cr	29-Jun-01	13.33	Autolysis	
4779-028	R luteiventris	Larva	YNP/Grebe Lake	08-Jul-01	2.31	Susp.Ranavirus	Pinworms
4779-012	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.65	Normal	Pinworms
4779-013	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.64	Autolysis	Subcutaneous edema
4779-014	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.57	Depigmented tooththrows	Pinworms
4779-015	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.67	Normal	Subcutaneous edema
4779-016	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.51	Susp.Ranavirus	Autolysis
4779-017	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.66	Susp.Ranavirus	Malformed tooththrows
4779-018	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.49	Predation/scavenged	Pinworms
4779-019	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.43	Normal	Pinworms
4779-020	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.35	Autolysis	
4779-021	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.56	Normal	Subcutaneous edema
4779-022	Ps. maculata	Larva	YNP/Grebe Lake	10-Jul-01	0.34	Autolysis	Saprolegniasis
4779-034	R.luteiventris	Larva	YNP/Grebe Lake	10-Jul-01	1.29	Autolysis	
4779-035	R luteiventris	Larva	YNP/Grebe Lake	10-Jul-01	1.31	Susp.Ranavirus	Autolysis
4779-036	R luteiventris	Larva	YNP/Grebe Lake	10-Jul-01	0.90	Autolysis	
4779-037	R luteiventris	Larva	YNP/Grebe Lake	10-Jul-01	0.60	Autolysis	
4779-003	A.tigrinum	Larva	YNP/Rainy Lake	11-Jul-01	3.40	Susp.Ranavirus	Saprolegniasis
4779-004	A.tigrinum	Larva	YNP/Rainy Lake	11-Jul-01	2.45	Susp.Ranavirus	Saprolegniasis
4779-032	R.luteiventris	Larva	YNP/Pelican Valley	13-Jul-01	1.98	Malformed tooththrows	Autolysis
4779-033	R.luteiventris	Larva	YNP/Pelican Valley	13-Jul-01	1.20	Susp.Ranavirus	Autolysis
4779-025	R. luteiventris	Adult	YNP/Chipmunk Cr	02-Aug-01	12.03	Autolysis	
4779-026	R. luteiventris	Adult	YNP/Chipmunk Cr	02-Aug-01	17.31	Autolysis	Gut nematodes
4779-027	R. luteiventris	Adult	YNP/Chipmunk Cr	02-Aug-01	33.70	Chytridiomycosis	
4779-042	R. luteiventris	Egg	YNP/Lodge Cr Lagoon	28-May-02	NA	7% dead moldy eggs due to <i>Achlya glomerata</i>	
4779-043	R. luteiventris	Egg	YNP/Lodge Cr Lagoon	28-May-02	NA	82% dead moldy eggs due to <i>Achlya glomerata</i>	
4779-048	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	21.32	Susp.Ranavirus	Chytridiomycosis
4779-049	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	23.03	Autolysis	Saprolegniasis
4779-050	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	9.85	Susp.Ranavirus	Renal metacercaria
4779-051	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	9.83	Susp.Ranavirus	Chytridiomycosis
4779-052	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	12.70	Susp.Ranavirus	Predation/scavenged

NWHC							
<u>Case&amp; Access.</u>	<u>Species</u>	<u>Life Stage</u>	<u>Site</u>	<u>Capt Date</u>	<u>Mass (gm)</u>	<u>Primary Diagnosis</u>	<u>Secondary Diagnosis</u>
4779-053	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	10.55	Susp.Ranavirus	Chytridiomycosis
4779-054	R. luteiventris	Adult	YNP/"Sewer Cr"	31-Jul-02	8.02	Susp.Ranavirus	Chytridiomycosis
4779-045	R. luteiventris	Adult	YNP/"Sewer Cr"	R9-Aug-02	20.60	Chytridiomycosis	
4779-046	R. luteiventris	Adult	YNP/"Sewer Cr"	R9-Aug-02	NR	Susp.Ranavirus	Predation/scavenged
4779-047	R. luteiventris	Adult	YNP/"Sewer Cr"	R9-Aug-02	7.02	Susp.Ranavirus	Chytridiomycosis
4779-055	R. luteiventris	Adult	YNP/"Sewer Cr"	8-Aug-02	44.70	Ranavirus isolated	Chytridiomycosis
4779-056	R. luteiventris	Adult	YNP/"Sewer Cr"	8-Aug-02	12.53	Ranavirus isolated	Autolysis
4779-057	R. luteiventris	Adult	YNP/"Sewer Cr"	8-Aug-02	22.57	Ranavirus isolated	Autolysis
4779-058	R. luteiventris	Adult	YNP/"Sewer Cr"	28-Aug-02	13.81	Ranavirus isolated	Chytridiomycosis
4779-059	R. luteiventris	Adult	YNP/"Sewer Cr"	28-Aug-02	8.23	Ranavirus isolated	Chytridiomycosis
4779-001	R. luteiventris	Adult	YNP/Lodge Creek	22-Aug-01	3.07	Myocarditis	Gut coccidiosis

### Abbreviations:

R, date specimen was received at NWHC

Cr, Creek

GTNP, Grand Teton National Park

NA, not applicable (ie, eggs were not weighed)

Susp, Suspected (indicates diagnosis is based solely on histological examinations)

NR, not recorded

NWHC, National Wildlife Health Center

RM, Recent metamorph (recently metamorphosed frog or toad)

RHL, Right Hindlimb

Riv, River

YNP, Yellowstone National Park

When "autolysis" (ie, decomposition) is listed as the "primary diagnosis", that indicates the animal was too decomposed to diagnose chytrid infection or ranavirus infection.

## **Abnormal Frogs at Lodge Creek Lagoon, 2003**

Six Columbia Spotted Frogs were collected live on 9/3/03 and sent to National Wildlife Health Center for analysis.

**Location:** Pond and stream at the mouth of Lodge Cr at Yellowstone Lake, 1.5 km south of Fishing Bridge      **Latitude/longitude:** N44° 33' 22"; W110° 23' 25"

**Species affected:** Columbia Spotted Frog (*Rana luteiventris*)

**Age/sex:** Young of the year. Metamorphosis occurred in early August, or later for some individuals.

**Morbidity/mortality:** 70 young frogs examined on Sept. 3-4; 63 were abnormal. No dead found.

**Clinical signs:** Swelling (multiple bumps) and ulceration of rump in tail bud area; grossly swollen bodies and throats; swollen and red upper hind legs; bleeding under the skin of the belly and legs; hard growths under the skin of back and belly. Frogs acted normally; lively and quick despite their diseased appearance.

**Onset:** Early August.

**Other populations in area potentially at risk:** Other spotted frog breeding populations exist in the area; two of these breeding populations are < 1 km distant. There is probably interchange among these and more distant populations (up to 2 km potentially). The breeding population just upstream of this area ('upper Lodge Cr') is known to have declined 80% since the 1950s, probably due to habitat loss and modification. Some frogs disperse from lower Lodge Cr to upper Lodge Cr; thus some of these diseased young of the year may reach the upper study area where no disease signs were observed this year.

**Population movement:** The young of the year were moving upstream from the breeding/rearing area in the pond at the mouth of Lodge Cr to winter habitat along the creek and in a small spring.

**Problem area description:** Lower Lodge Cr flows through a sage-forb-grass meadow and forms a large pond ("lagoon") at its confluence with Yellowstone Lake. Spotted frogs deposit eggs at the north and south ends of this pond. Young of the year and adults move upstream along the creek in mid and late summer. In late August and Sept, many young of the year gather at a very small spring about 25 m from Lodge Cr. They go underground into small cavities and possibly spend the winter highly congregated. Others may overwinter under the banks or in cavities along lower Lodge Cr.

Lodge Cr is a cutthroat trout spawning stream, and fish also occupy the lagoon.

The outbreak area is near Lake Lodge and is visited frequently by hikers.

**Notes:** Lodge Cr is a sentinel site for USGS ARMI monitoring. Spotted frogs were studied in this area in the 1950s, and have been monitored annually since 1991, but most of the monitoring work occurs upstream from this disease outbreak area. The affected area in lower Lodge Cr is monitored less intensively. No abnormal frogs with these symptoms were observed in the main study area, which is about 800 m upstream.

### **Findings by NWHC: These are excerpted from emails received from D. Earl Green**

The lumps in the skin around the urostyle are encysted metacercaria (immature flukes). Their location suggests the parasites originally were in the skin and muscle of the tail, and when the tails were resorbed during metamorphosis, these parasites clumped at the tip of the urostyle. I see this clumping of organisms around the urostyle with other species of metacercaria and with infections by the primitive fungus, *Ichthyophonus* (not yet seen in Wyoming's amphibians). Two of the frogs were markedly bloated---both had excessive amounts of pinkish fluid under their skin (in the lymphatic sacs). One had markedly reddened pelvic patch. These two findings are suggestive of Ranavirus infection, but could have other causes. Virus cultures will be started....

I doubt the parasites will cause death in the frogs, although, I still think there was ulceration and loss of skin covering some of these encysted metacercaria at the tip of the urostyle. Skin ulcers mean the frogs could be susceptible to routine secondary bacterial or fungal infections (ie, wound infections). I do not think there is any connection between the parasites and the possible Ranavirus infection in these frogs. However, it is possible the encysted metacercaria were blocking or plugging the lymph hearts on each side of the urostyle; such plugging of the lymph hearts could result in back up of fluid, or fluid accumulation, under the skin, as seen in the frogs. But the pinkish color of the excess fluid worries me, and suggests a second disease (ranavirus?) rather than simple mechanical plugging of lymph hearts. (9/12/03)

The metacercaria from the rumps of the *R. luteiventris* were identified only to family. They are Diplostomatidae. These metacercaria are most commonly reported in fish, but that probably is because more fish are examined for parasites than amphibians. Hence, with an absence of data and literature, it is difficult to say whether this group of metacercaria prefers to infect fish or amphibians, or whether they are merely "generalists" that infect anything larger than them that is swimming in the pond! The impression I received from our parasitologist is that metacercaria in this family are very difficult or impossible to identify to genus and species, so I do not know if any further identification will be possible. (10/10/03)

Preliminary Progress Report from NWHC in November 2003 showed primary diagnosis for these 6 frogs as "subcutaneous effusion" and minor diagnosis as "muscle metacercaria".



Ulcerated swellings in urostyle area, spotted frog metamorph at Lodge Cr lagoon, photo 8/8/03



Bloating, redness, and bumps under skin, spotted frog metamorph at Lodge Cr lagoon, frog collected 9/3/03



Bloating of body, and swellings in urostyle area, spotted frog metamorph at Lodge Cr lagoon